MP MAS
MA32844

conoptics

Conoptics Laser Modulation System

Owners Manual

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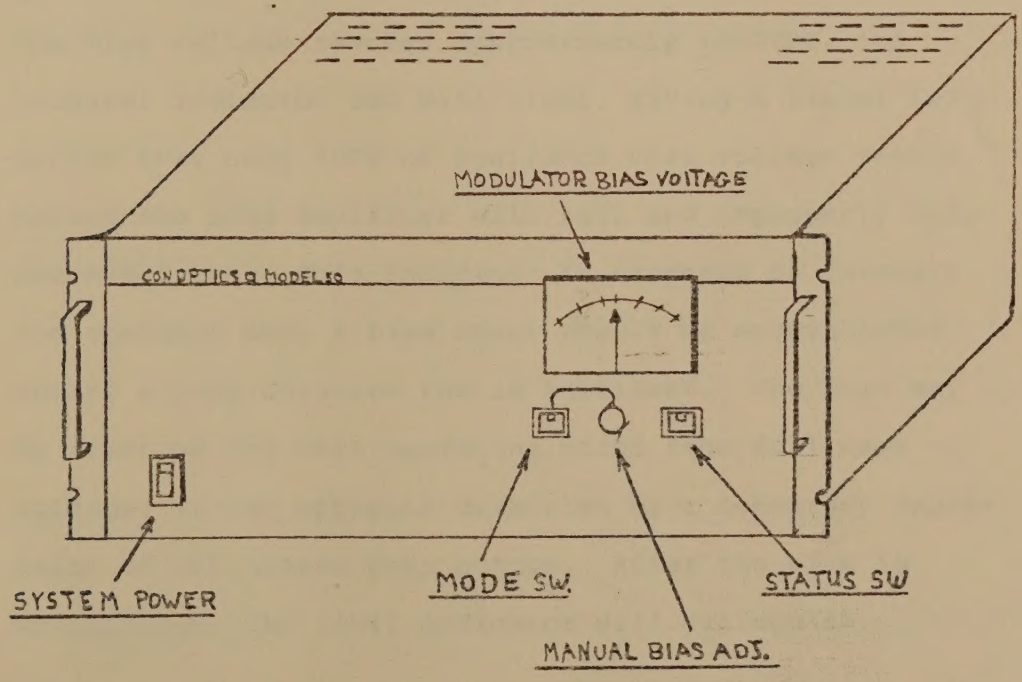
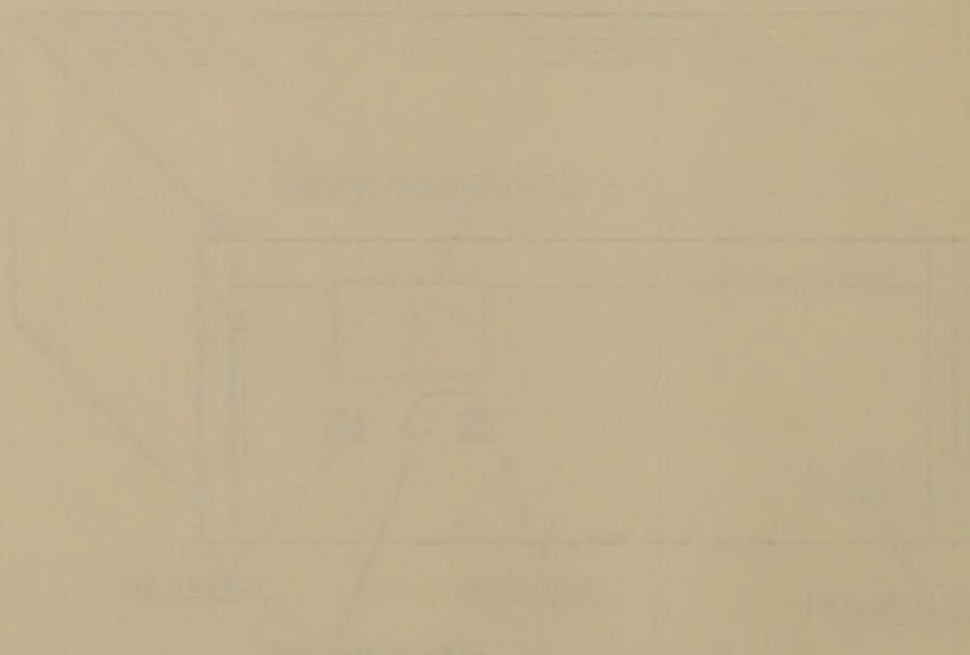
1.1 Conoptics series of Laser Modulation Systems are designed to intensity modulate most CW gas lasers. All systems are completely DC coupled and are easily interfaced to. Both digital and analog signals are readily accepted by the Class A linear RF Power amplifier. The electronics enclosure is rack mountable and interconnecting cable between modulator and drive electronics are of sufficient length to allow remote locating of the electronics package. Applications include analog or digital recording on photosensitized mediums, information transmission through free air or fiber optic cables, and a variety of research applications.

1.2 Controls and Indicators





Power - This switch applies primary power to the electronics package. An integral indicator lamp signifies power on condition.

Mode Switch - This switch controls how the modulator bias voltage is derived. In the manual mode (indicator lit), this voltage is controlled by the front panel bias potentiometer. When the indicator is extinguished, the bias voltage is controlled by one of the closed loop bias servo options. The manual adjust potentiometer is disabled in this mode.

Status - This control is provided as both a visual indicator of an approaching physical limit of available bias voltage and a manual reset input. The system has a ±250VDC capability for modulator bias voltage. When the bias voltage reaches approximately ±150VDC, the integral indicator LED will light, giving a visual indication that only 100V of available bias voltage remain before the bias amplifier will rail and improperly bias the modulator. This indicator is intended to forewarn the operator that a bias reset should be accomplished before a long duration run is initiated. The bias may be reset to the next operating point (one full wave voltage) in the opposite direction by a momentary depression of the status push button. After the bias is re-acquired, the limit indicator will extinguish.

Bias Voltage Meter - This meter indicates the actual differential bias voltage applied to the modulator. Systems ordered without the auto bias servo will be equipped with the manual adjust potentiometer and bias meter only.

1.3 Installation Instructions - Refer to the installation drawing in the schematic section and connect the driver and modulator as shown.

The system should not be run without the cables interconnecting the electronics package and the modulator. In the Model 25, 50, and 100 systems, the DC load for the amplifier is carried through the modulator. Operation of the amplifier without interconnecting cables providing a DC path may result in serious damage to the output stage of the amplifier. The amplifier may be run without the modulator by bypassing the modulator with one of the interconnecting cables.

After the modulator and electronics package have been interconnected, turn on system power and allow the amplifier to run while proceeding through the System Operation section. Do not apply an input signal to the system at this time.

1.4 Interface Requirements.

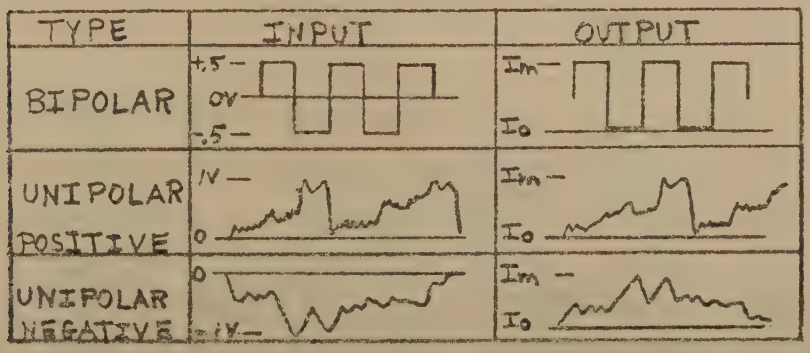
Input Power - All domestic systems are configured for operation at 120VAC $\pm$ 10% 60HZ. Japanese input power

requirements are 100VAC ± 5% 50-60HZ. European systems require 230VAC ± 10% 50HZ. The proper primary fusing is noted on the rear panel identification label.

Video Input - All systems are configured for a 1v p-p input signal. The drive electronics will deliver its maximum output signal with this input. Overdriving the input will result in saturation and cutoff of the amplifier, resulting in "storage" delays which will significantly effect the response of the amplifier. Input signals in excess of 4.0V may seriously damage the front end of the drive electronics.

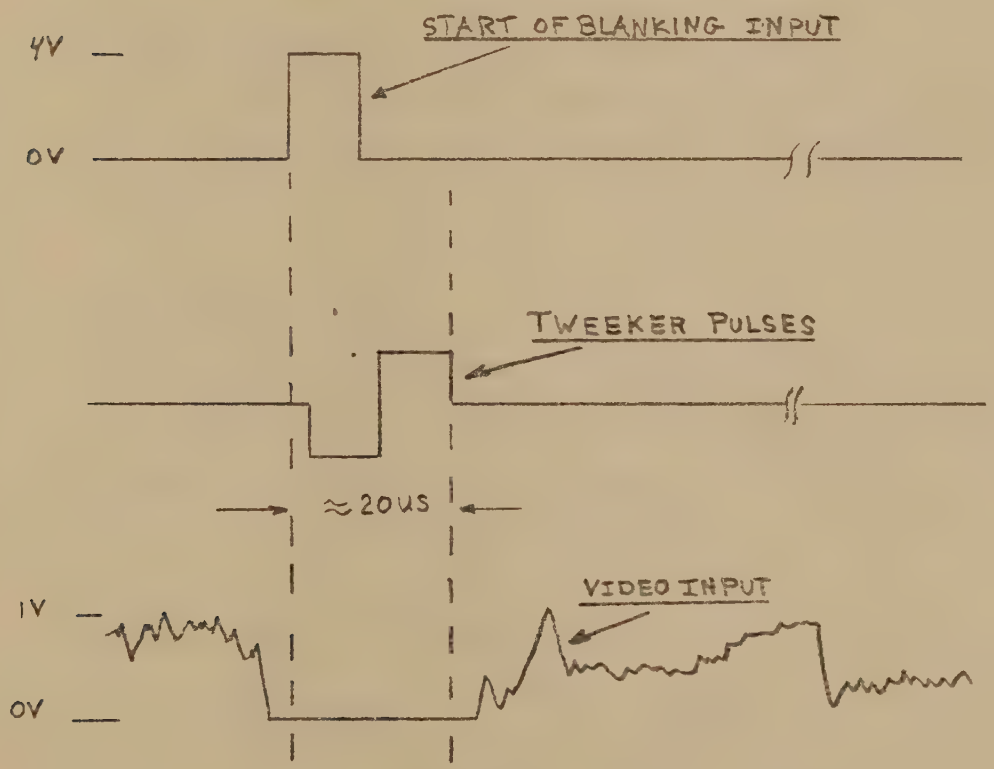
The system will accept either bipolar or unipolar input formats by adjusting a single control on the amplifier proper. Systems configured with the continuous auto bias servo will be shippped with the amplifier adjusted for a bipolar (±0.5v p-p) input. Sampled Auto Bias Servo Systems will be shippped configured for a positive unipolar (0.0V to 1.0vp-p) input.

Systems without auto bias control are shipped setup for a unipolar positive going input as in the sampled configuration. In all cases, the modulated laser output (with auto bias control will be non-inverting.



(Fig. 1.4a)

Start of Blanking - Start of blanking is a TTL positive true pulse of which the leading edge is used as the trip. The pulse should be a minimum of lus pulse width with a minimum repetition rate of 100HZ. The driving gate should be capable of delivering 4.0V into 120 ohms to ground. The auto bias electronics will be active for approximately 20us from the leading edge of the start of blanking pulse.



(Fig. 1.4b)

The video input signal must be at the level that is intended to be minimum transmission during the blanking interval. Refer to Figure 1.4b, the video input should go

to 0.0v about 500ns before the leading edge of the start of blanking pulse to allow the analog portion of the auto bias servo to settle out. It must stay at 0.0v during the entire blanking width (20us). The video signal is free to vary immediately after the end of the second tweeker pulse as the loop disables itself on the trailing edge of this pulse.

Section 2.

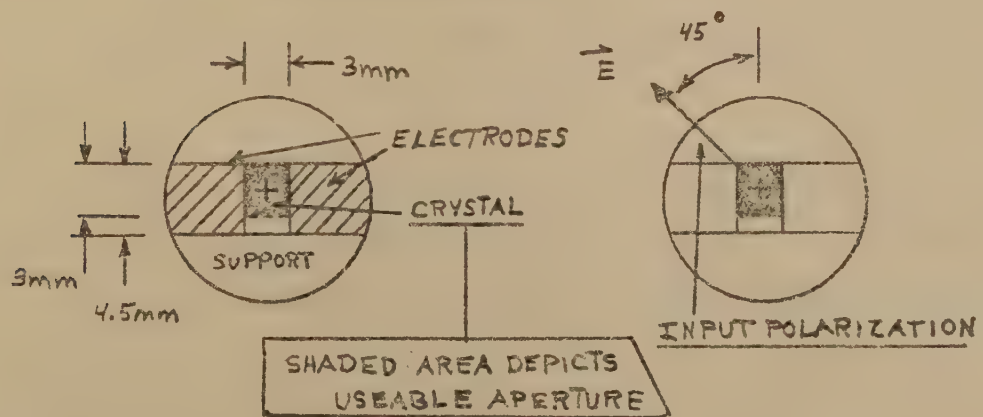
System Operation

The following alignment procedures should be followed in sequence for proper integration into the users system.

2.1 Modulator Alignment

All systems, independent of modulation bandwidth use the same geometry crystals. The following modulator alignment procedure may be used for all types of Conoptics electro-optic modulators.

1.1 Refer to Figure 2.1A.



(Fig. 2.1A)

The physical geometry of the crystals is 3 by 4.5mm. The useable aperture of the crystals is actually 3mm square due to the birefringence of the crystal material. The laser should be adjusted for low output power (less than 50mw). Align the modulator to the laser beam such that there is no evidence of vignetting at the output. (The input end cap centrally locates the useable aperture.) If possible, a viewing screen should be employed at the output (about 1/2 meter) end of the modulator. This will aid in determining if there is internal vignetting due to improper X-Y alignment. The exiting beam should be free from scatter and show no evidence of deformation of beam geometry.

Monitor the output beam intensity with a suitable power meter and proceed as follows:

Place the bias control switch in the "Manual" position and adjust the manual bias control potentiometer on the front panel for a maximum reading on the power meter.

Rotate the modulator on axis to further maximize the reading on the power meter. Re-adjust the manual bias adjust for max. This is an iterative

process that aligns the laser input polarization to bisect the optical axis of the crystals.

Adjust the bias adjust pot for min power throughput, rotate the modulator slightly in either direction to see if the minimum can be improved without effecting the maximum. (A few degrees in either direction should be adequate.) Proper alignment is accomplished when both transmission and extinction ratio are maximized.

$$\% \text{ Transmission} = \frac{\text{Pout} \times 100.}{\text{Pin}} = \frac{520\text{mw}}{890\text{mw}} \times 100 = 58.4\ \%$$

$$\text{Extinction Ratio} = \frac{\text{Pmax (out)}}{\text{Pmin (out)}} = \frac{520\text{mw}}{4\text{mw}} = 123$$

2.2 Beamsplitter Alignment

There are two different configurations of beamsplitter/pickoff assemblies. The first type is supplied with continuous auto bias. This assembly employs two photovoltaic detectors, one to monitor the throughput component and another to monitor the rejected component. Each detector has a separate beamsplitting cube that allows the incident energy on each detector to be adjusted between 0 and 1%.

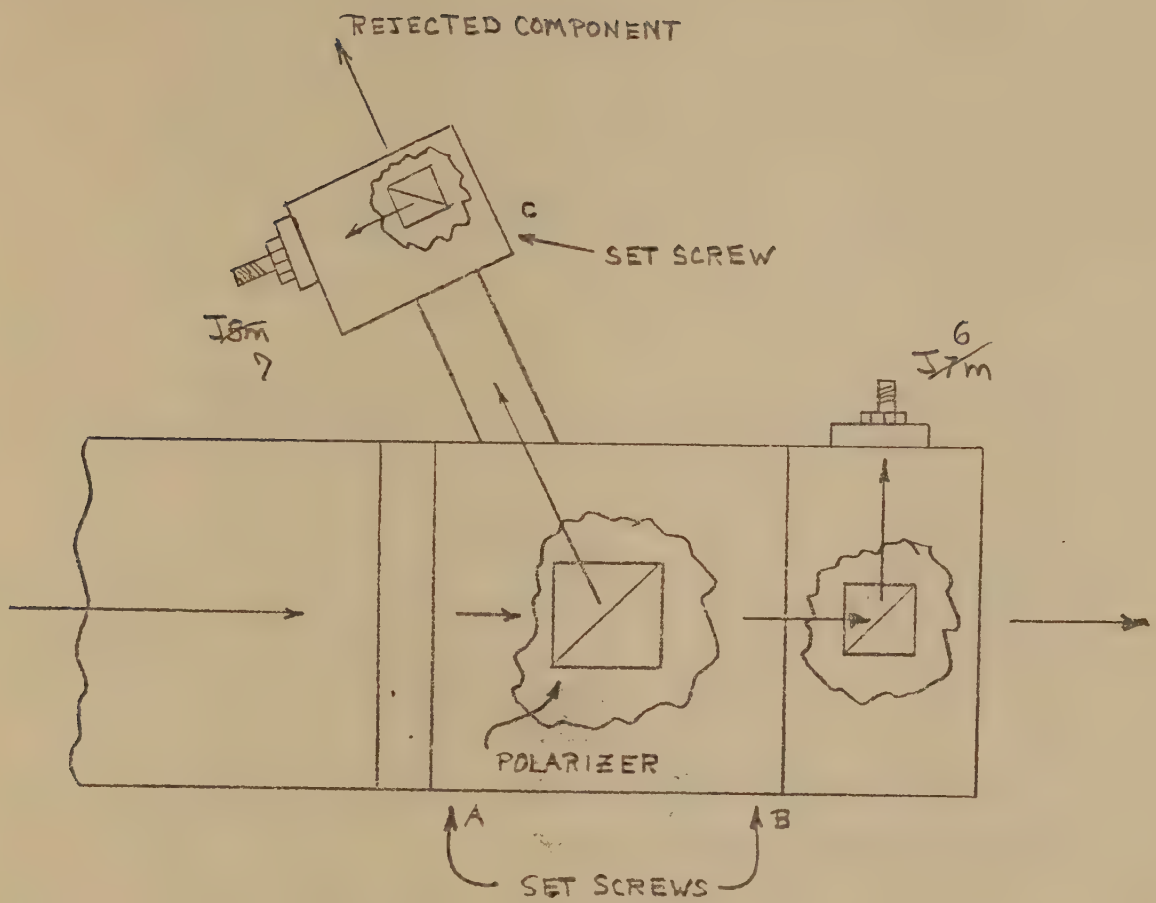
The second type is supplied with sampled auto bias. This type employs a single PIN detector, samples the throughput component only, and, as in the continuous

type, is adjustable from 0 to 1% of the incident beam power. There is no alignment required in the sampled type other than to adjust the incident power level. This alignment is covered in Section 2.4 (Automatic Bias Control Alignment).

Continuous Auto Bias Beamsplitter Alignment:

Refer to Figure 2.2A.

The following beamsplitter alignment will result in the maximum amount of light (1%) deflected to the photocell. Loosen Set Screw C, and position connector J7m so that the connector body is parallel to the axis of the cylinder and tighten Set Screw C. Use a sheet of paper held against the aperture on the top of the J7m assembly to ensure that the beam is exiting in the center of the aperture. If adjustment is required, loosen Set Screw A and move the assembly until the rejected component is exiting in the center of the J8m aperture, tighten Set Screw A. Loosen Set Screw B and approximately align connector J6m perpendicular to the plane containing the modulator cylindrical axis and the rejected component. Tighten Set Screw B. This alignment of the two beamsplitters should permit operation at input power levels between 50mw and 150mw. If the laser input power is higher than 150mw, then the coupling to the photodiodes should be reduced by



Conoptics Beamsplitter/Photo Cell Assembly

Continuous Auto Bias Control

(Fig. 2.2A)

adjusting them closer to the zero coupling position, which is 90° to the alignment described above.

Figure 2.2B depicts the sampled auto bias beamsplitter assembly. The pickoff coefficient is adjusted by loosening the three Set Screws on the periphery of the assembly and rotating the entire end piece about the optical axis 0 to 1% is accomplished by rotating the unit 90 degrees.

2.3 Power Amplifier Alignment

No adjustment of the power amplifier is required if the users video input format is as described in Section 1.4. In the 10, 25 MHz systems, the amplifier is calibrated during test to deliver 90vp-p with a 1v input. In the 50 MHz and 100 MHz systems, a 1v input will deliver an 80V p-p output. Being that the modulators half wave voltage (that voltage required to rotate the plane of polarization 90°) is wavelength dependent, the p-p output voltage of the driver will effect the detected dynamic range.

$$I_o \approx I_m \sin^2\left(\frac{\pi}{2}\,\frac{V_{633nm}}{V_{\lambda nm}}\right)$$

	458nm	488nm	514nm	633nm
10, 25mhz SYSTEM	100%	100%	99%	85%
50, 100Mhz SYSTEM	99%	97%	94%	77%

If the user wishes to calibrate or normalize the video input to the detected output, the forward gain of the amplifier may be adjusted to yield the required output swing for a particular input signal. In the 10, 25, and 50 MHz systems, the input attenuator may be adjusted to provide the proper output. The 100 MHz system has only a vernier adjust of approximately ±20%. One may normalize the input signal to .5V (a low frequency square wave is recommended) by adjusting the input attenuator (Refer to the appropriate schematic and layout drawing) such that the detected output is .5 of Tmax. This will normalize the detected output to a 1vp-p input. This calibration is required if the users input signal level has to be correlated to the modulated laser power. For example, in many recording applications, the video input signal is pre-distorted to compensate for the Sin^2 transfer function of the modulator/polarizer. In this situation, the detected output must be calibrated to the video input, point for point or else the overall transfer function will not yield the desired results.

2.4 Automatic Bias Control Alignment

Continuous Auto Bias Control -

Assuming the photocell pick-off alignment has been properly executed, the following procedure will align the feedback loop for correct auto bias operation.

Initial Conditions

1) Modulator properly aligned to laser.
2) Photocell pickoff alignment complete.
3) System power on; no input signal to drive elctronics.
4) Bias control in manual mode.
5) Laser output power and wavelength set to system requirements.

Procedure

Connect throughput sample photocell output (J~~7~~6m) to digital voltmeter. Place the DVM in the DC current mode and adjust the manual bias control potentiometer for maximum modulator transmission. This should be maximum photocell output current as well.

Loosen Set Screw B and rotate collar so as to position the photocell current as close to ~~200~~100ua as possible. (Bias adjustment max transmission.) Lock Set Screw B, monitor J~~8~~7m in a similar manner as previously described, adjust bias control pot for minimum transmission and loosen Set Screw C. Again, adjust beamsplitter pickoff coefficient by rotating pickoff block for approximately ~~200~~100ua of rejected component photocell current. Lock Set Screw in place. Reconnect both pickoff cables to their appropriate connector on the rear panel of the drive electronics.

Limits on photocell output current for proper loop operation are as follows:

100 ua minimum (approximately 50mw @ 458nm)

300 ua maximum (approximately 150mw @ 458nm)

The auto bias loop will function properly between these two limits of photocell current. However, to provide the greatest latitude in operating point adjustment, the photocell current should be adjusted (via beam-splitter pickoff coefficient) to lie at the mean of the min and max limits, if possible.

(J-10)

Monitor P.D. Test 1, (Rear Panel) with a high input impedance oscilloscope (1 MEG Zi), and adjust the manual bias adjust potentiometer to obtain a maximum negative voltage. Remove the top cover of the drive electronics and adjust R2, see component layout number 100019 to obtain -1.0v @ P.D. Test 1

(J-11)

Monitor P.D. Test 2 and repeat the above procedure while adjusting R8 to obtain -1.0v @ P.D. Test 2.

The loop is now roughly calibrated. Connect the video input. Monitor the throughput laser beam with an approximate PIN photo diode (FND-100 mfg. by EG&G or equivalent) and an electrical spectrum analyzer. Adjust the incident light on the diode with a separate polarizer such that the maximum diode current is in the order of 1ma maximum.

Place the bias control switch on the front panel in the Auto mode. The loop should position the detected output signal in the middle of the Sine squared transfer function of the modulator/polarizer combination.

Monitor the even order terms of the input fundamental with the spectrum analyzer and adjust R8 in a manner to minimize the even order terms on the screen of the spectrum analyzer. Typical levels of even order terms should be = -55db below the fundamental. The loop will now hold this operating point independent of time and temperature. Re-install the cover on the drive electronics.

NOTE: The above procedure assumes a 50% duty cycle, FM encoded input format. The loop will not function properly if the duty cycle deviates from 50% as this control circuit operates on the average DC term of the output signal.

Sampled Auto Bias Alignment

The beamsplitter/photocell assembly samples the throughput laser power. It is adjustable from approximately 0 to 1% of the throughput intensity.

The beamsplitter is pre-aligned at the factory to place the sample beam in the center of the photodetector's useable aperture. The only adjustment that is required is calibrating the magnitude of the sample intensity impingent on the detector. Minimum input intensity to

the modulator is in the order of 200mw at 488nm for the 1% beamsplitter. The following procedure will calibrate the beamsplitter sample coefficient to the desired laser throughput power.

Pre-Conditions -

1) Modulator properly aligned to laser.

2) Laser output power adjusted to the desired level.

3) No video input connected to driver.

4) Start of blanking pulse connected to rear panel. (Start of blanking command is - T^2L positive true, minimum pulse width is 1 us, minimum repetition rate is 50 Hz. The actual time required for auto bias update is approximately 20 us and is independent of input signal pulse width.)'

Turn system power on, monitor the PD test connector (BNC) on the rear panel with an oscilloscope terminated in 50 ohms. Place the bias control switch on the front panel in the manual mode (Indicator lit). Adjust the manual bias adjust potentiometer on the front panel to obtain maximum modulator transmission.

Refer to Figure 2.2B and proceed as follows:

Loosen the locking Set Screws and rotate the pickoff so as to obtain +0.5V out of the PD test PNC connector. Lock the beamsplitter in place by tightening the locking Set Screws. Provided that a start of blanking pulse is present at the rear panel connector, the bias control

connector, the bias control switch may be placed in the auto mode and the bias servo loop should place the modulator's transmission at minimum. Refer to Figure 2.4A for typical timing diagram for auto bias and video input.

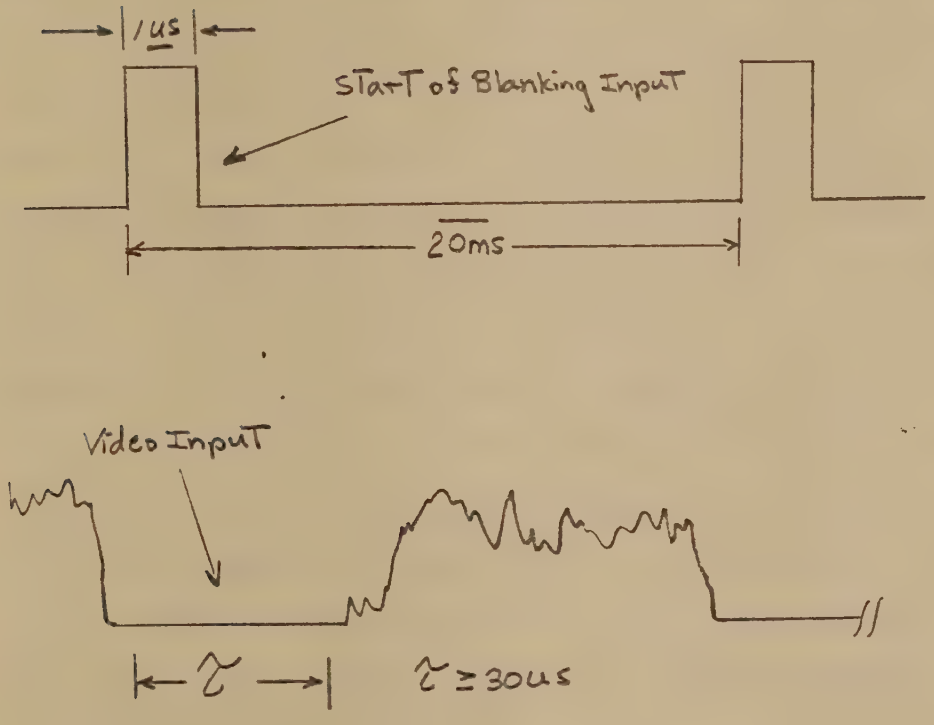


Fig. 2.4A

NOTE: During time τ, the video input level as supplied to the drive electronics must go to minimum transmission (typically 0.0V). The loop will always interpret this level as minimum transmission independent of the actual voltage supplied.

Monitor the throughput laser power with an appropriate power meter. Place the bias control switch in the manual mode and adjust the manual bias adjust potentiometer for minimum transmission. Note the reading on the power meter and place the bias control in the auto mode. The reading on the power meter should be the same for both manual and auto operation. If the auto mode does not yield the same minimum as may be obtained in the manual mode, a minor adjustment may be necessary.

Remove the top cover and refer to Sampled Auto Bias Layout Drawing 100025. Adjust either pot on RN5 to make the auto mode yield the same minimum as the manual reading. Either pot should not be at a mechanical stop. If one control winds up at a stop, the other control should be used and the original pot brought somewhat towards its mechanical center.

THEORY OF OPERATION

Output Stages

(Refer to schematic #100005).

The output stage is cascode connected push-pull configuration. Q13, the output device, is run in the grounded base mode and is driven by four current drivers. This connection is a very broadband configuration as there is no miller effect.

The breakdown voltage of the output device is extended to BVCEs as the source impedance of the base biasing circuitry is extremely low. Each push-pull output is capable of putting out more than 17W of RF. power DC- 100 MHz. Q1-Q4 form the required impedance converters to drive the low input impedance of the cascode output. The signal propagates out of the driver to the modulator (no power is absorbed in the modulator).

The modulator is voltage dependent only and all components within the modulator are ideally reactive. Some very small amount of power may be dissipated within by "Real" losses in various inductors and capacitors. After the signal propagates through the modulator, it is properly terminated by the high power load resistors R38 and R37 The path also provides the Vcc for the output stage. Running the amplifier without the cables connected effectively removes the DC path to the output and as a result, the emitter-base

junction tries to deliver the current demanded by Q9-Q12.

Ft. Doubler

(Refer to schematic #100007).

Q15-Q20 forms a cascode connected ft doubler. Again, this is a very broadband connection as it eliminates any miller capacitance. Q16 and Q17 are cross connected such that their respective collector currents sum with Q18 and Q15. This summing effect makes the "DHE" drivers appear to be delivering twice the current that they normally would be and at ft the effective current in Q20 is greater than unity as would be the case for a normally connected cascode differential amplifier. The amplifier is driven by the paraphase amplifier, push-pull. Ft doubler stage gain is approximately 7.5.

Input Paraphase (Q1-Q7 and Q8-Q14)

This amplifier takes the single ended input and converts it to a differential output to drive the other amplifiers. It provides a small amount of gain and also does the required level shifting to drive the ft doubler. The amplifier gain and differential balance controls are located in this section of the amplifier string.

Input Electronics Reference Supply

The reference power supply provides a stable DC bias

voltage to the ft doubler electronics. This voltage is adjustable within limits to bias Q16, 17, 22, 24 of the ft doubler. R71 & R81 of the reference supply provide the adjustment capability, nominal output voltage is -3.5V.

Modulator Bias Amplifier.

This amplifier provides the modulator with the required high voltage to set the quiesent operating point. It is capable of delivering plus/minus 300V DC to the optical head. In the manual bias mode, it is driven by the front panel "Mod bias" potentiometer. In the automatic mode, it is driven by the auto-bias electronics. There is a differential balance R84 and a common mode adjust R89 which are factory set and require no adjustment by the customer.

3.2 100 MHz Drive Electronics.

Amplifier Alignment.

There are two adjustments that may be required of the drive electronics dependent on the users video input format. They are gain and differential balance.

Gain - This control is provided to allow calibration of the input-output transfer function of the overall system. In both analog and digital applications, it may be necessary to accurately calibrate the peak to peak output swing of the drive electronics to the particular operating laser wavelength.

Differential Balance - This control is provided as a means of optimally biasing the power amplifier for various video input formats. Being that the amplifier is DC coupled, the proper quiesent operating point of the amplifier will be dependent on the input format (Unipolar/Bipolar).

If required, the differential balance should be adjusted before the gain calibration.

Differential Balance Adjustment -

Unipolar Positive Input (0 to plus 1.0V)

(Refer to drawing numbers 100005 and 100006).

Monitor test points #1 and 2 on the right output stage, (facing the front panel). Test point #1 is noninverting, #2 is inverting, with an oscilloscope. Adjust R27 such that the #1 test point reads plus 30.0V and test point

#2 reads 64.0V. Repeat procedure and adjust R5.

Unipolar Negative Input. (0 to minus 1.0V)

Same as above, except test point #1 reads 32.0V and test point #2 reads 15.0V.

Repeat procedure for left output stage and adjust R5.

Bipolar Input.

Both test points on each output should read the same voltage (approx. 46V).

Driver Gain Adjust.

Monitor internal test points as in previous description. Connect a function generator to the video input on the rear panel. Set function to square wave, frequency to 1KHZ, amplitude to 0.5V p-p. Adjust function generator to simulate input format (bipolar, unipolar, etc.). Monitor both test points with the oscilloscope simultaneously. Invert one channel and add algebraically. R9 & R25 (see component layout #100004) are vernier gain adjust pots for the left and right side respectively. The following output voltages should be present at the test points for their respective laser wavelengths. (44V p-p @ 458nm; 46V p-p @ 488nm; 49V p-p @ 514 nm.)

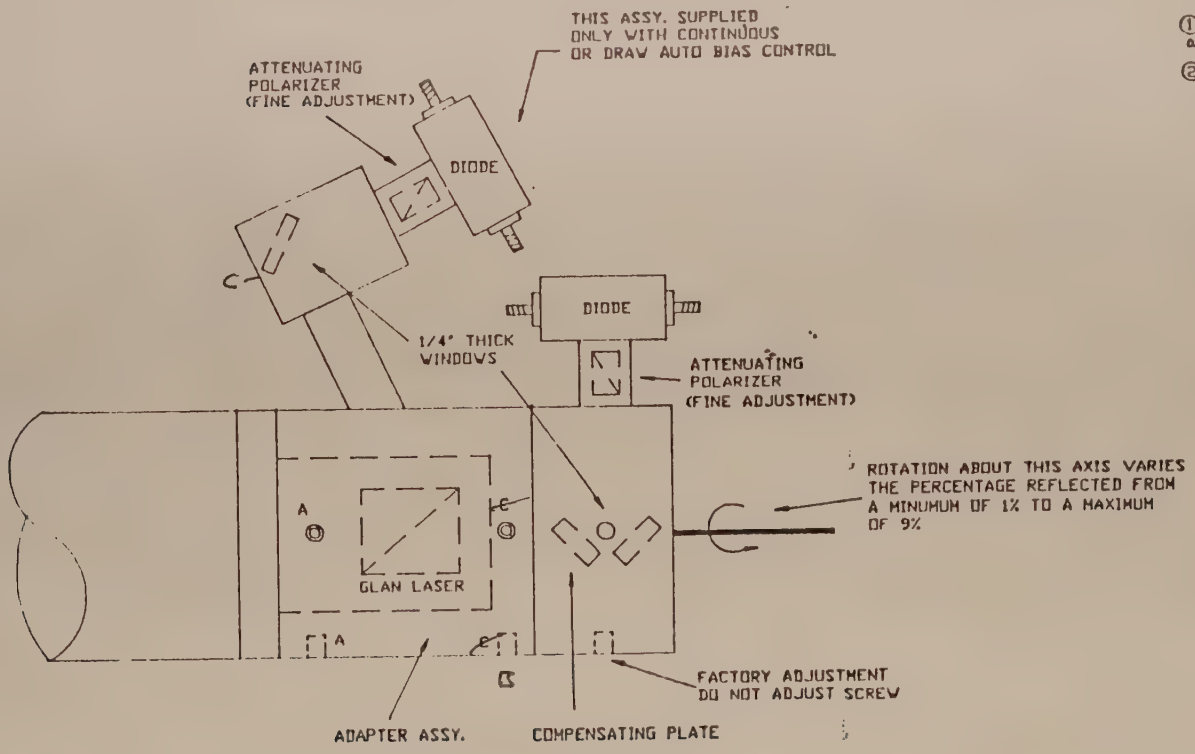
3.3 Automatic Bias Control

Continuous Auto Bias Servo -

The continuous auto bias servo electronics is designed to control the average optical power in the throughput and the rejected port of the E.O. modulator.

Current to voltage converters A1 and A2 take the current generated by the two photovoltaic detectors in the pickoff assembly and convert it to a proportional voltage. This voltage is then sent to A4, the high gain error amplifier, where it is operated on by both A4 and the bias amplifier in such a manner as to make both input levels equal. This will position the operating point of the modulator at the 50% transmission point. A unity gain buffer A3 drives the rear panel test points for calibration purposes.

The output of A4 drives the bias amplifier, a sample of this output is taken by A5, an absolute value amplifier, which converts the bipolar output of A4 to a proportional unipolar signal. As an output limit is reached, a dual comparator (A6) senses the amplitude and phase of the proportional signal and arms the reset circuitry. A7, a CMOS switch, provides the forcing function and the steering is provided by A8. When a limit is reached and the reset function is enabled, A7 will force a current into one or the other current to voltage converters to force the loop to hunt for a new operating point one


THIS ASSY. SUPPLIED ONLY WITH CONTINUOUS OR DRAW AUTO BIAS CONTROL
ATTENUATING POLARIZER (FINE ADJUSTMENT)
DIODE
DIODE
1/4" THICK WINDOWS
ATTENUATING POLARIZER (FINE ADJUSTMENT)
ROTATION ABOUT THIS AXIS VARIES THE PERCENTAGE REFLECTED FROM A MINUMUM OF 1% TO A MAXIMUM OF 9%
A
A
GLAN LASER
A
FACTORY ADJUSTMENT DO NOT ADJUST SCREW
ADAPTER ASSY.
COMPENSATING PLATE

ROTATION OF BEAMSPLITTER ASSY.

① loosen the two set screws [C] on the adapter assy.

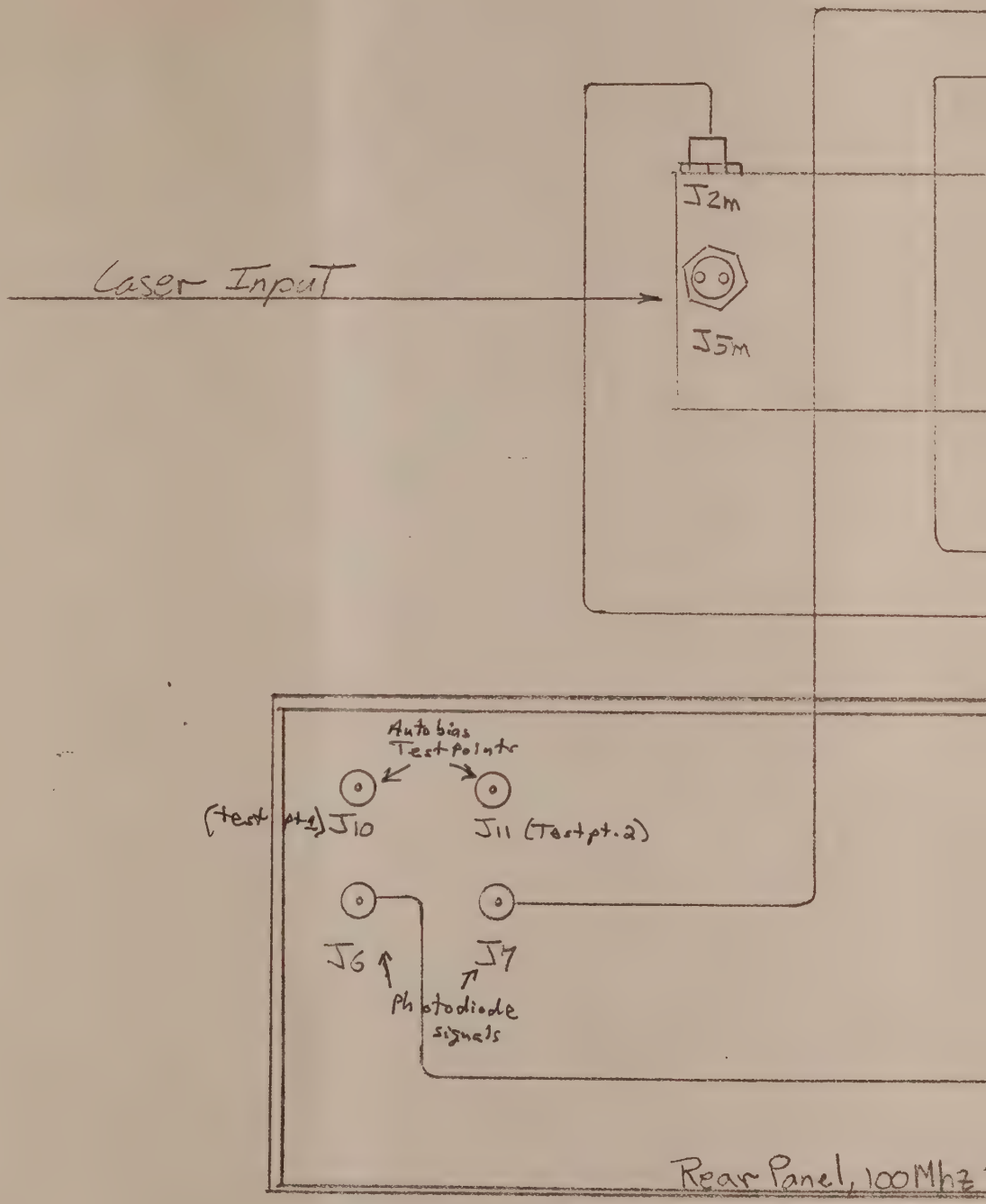
② rotate beamsplitter

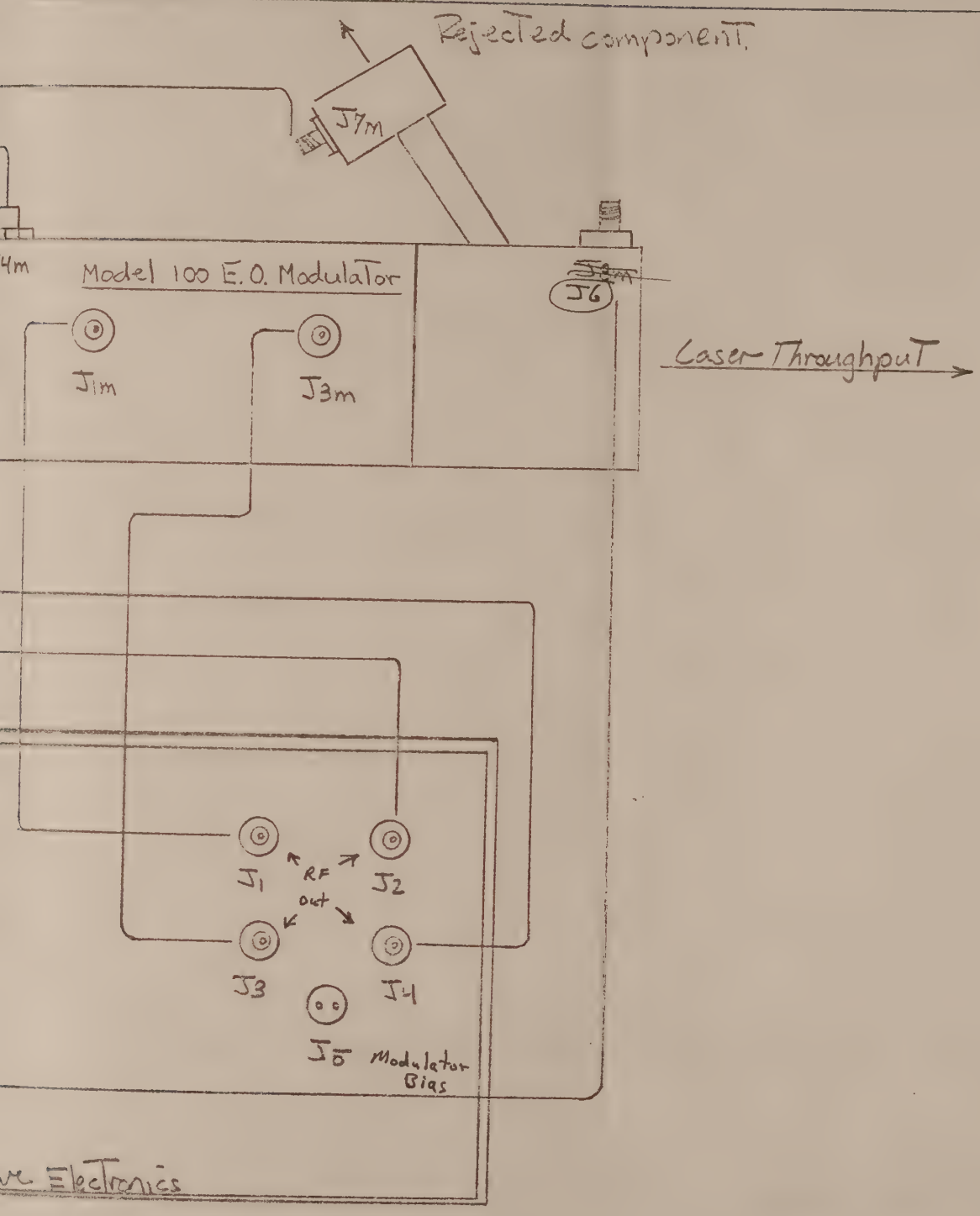
full wave away from the preset limit. The limit trip is set by R22. Relay K1 selects either manual or auto operation as determined by the front panel mode select switch. A10 locks the forcing function in until it is cleared by the comparator A6.

BY .....DATE .....
CHKD. BY .....DATE .....

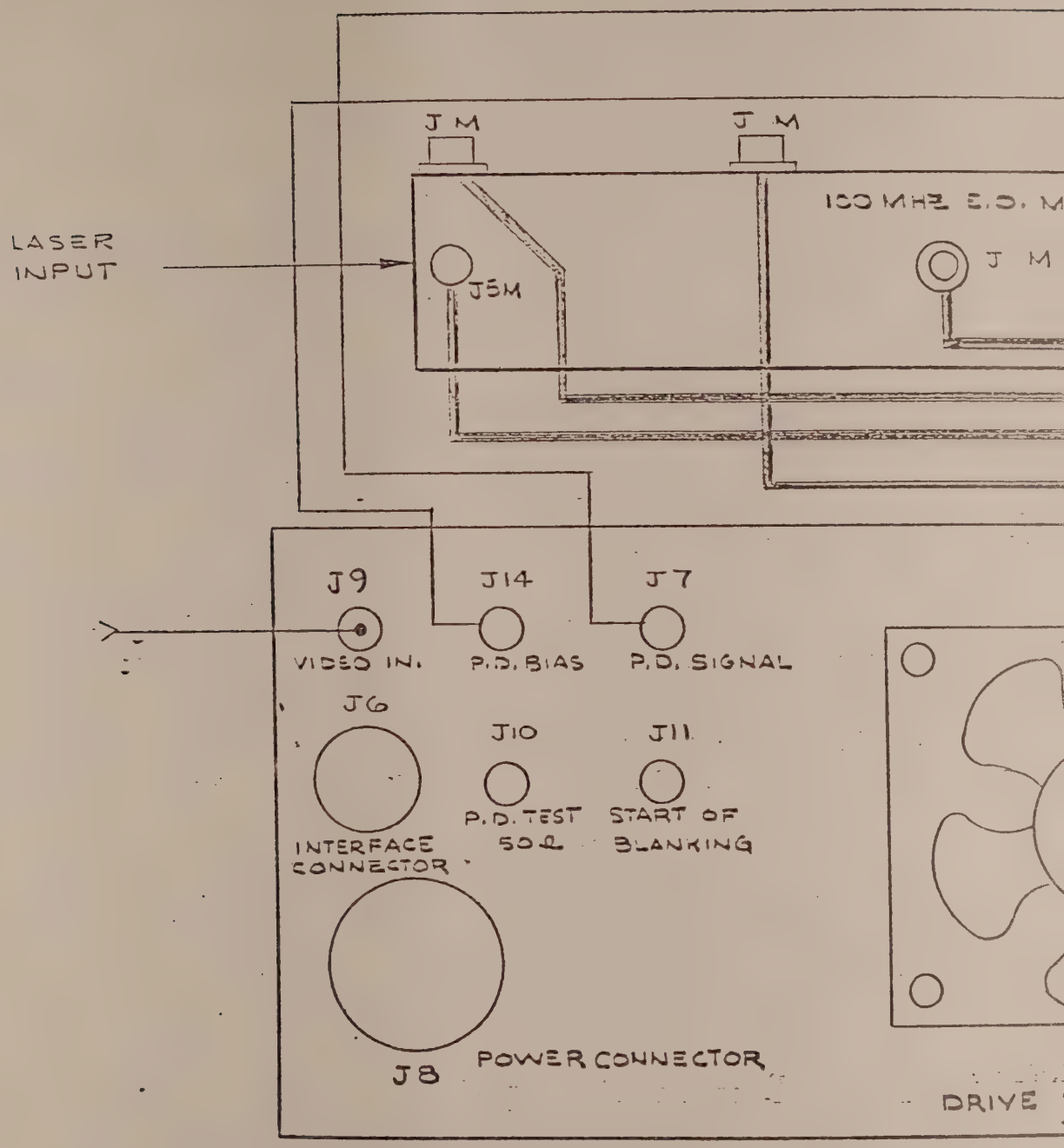
SUBJECT .....

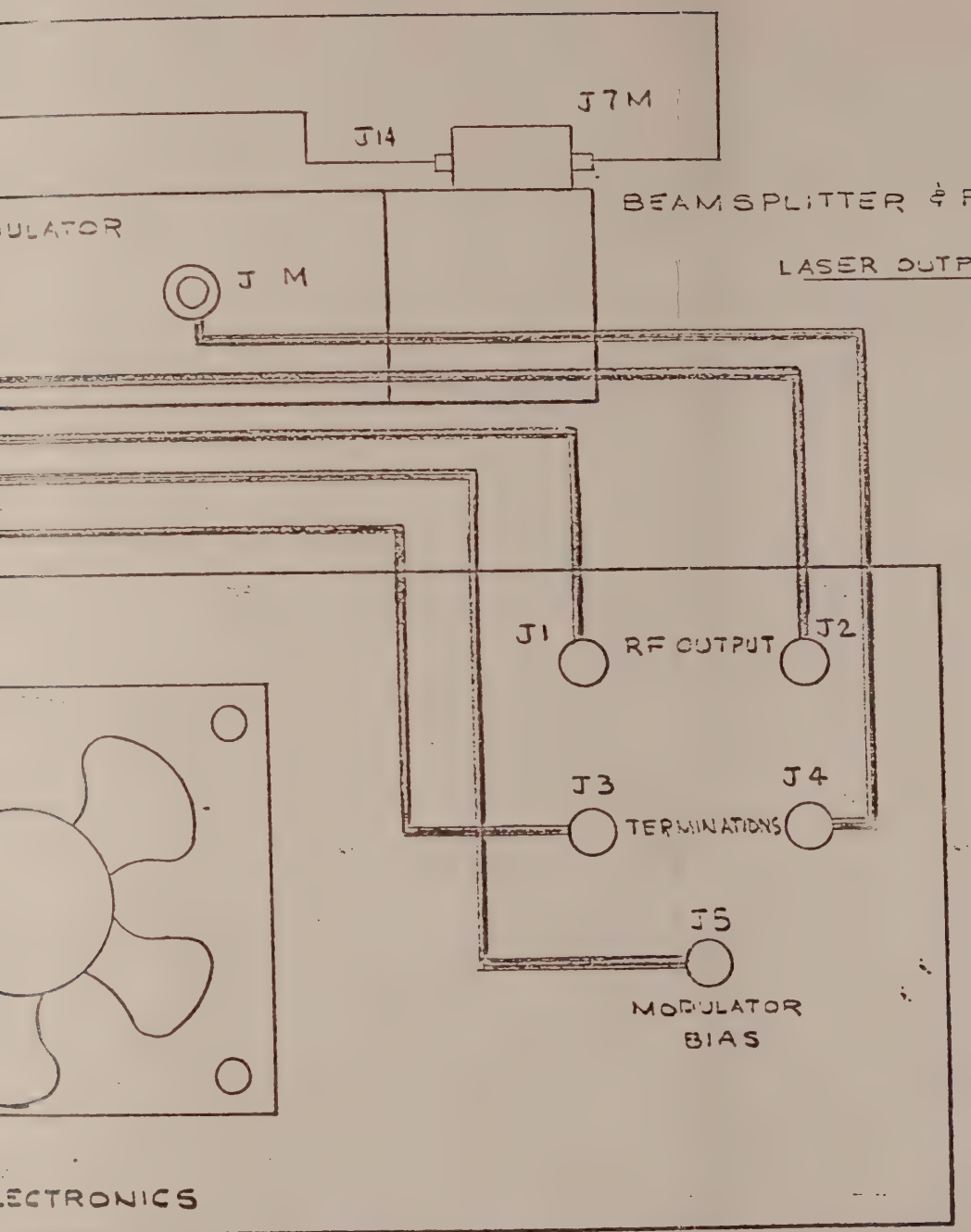
SHEET NO. ..... OF.....
JOB NO. .....





Conoptics Inc. Danbury CT.	
Drw.	Installation Drawing
Eng.	Model 100 w/ Continuous Bias
ck	


J M
J M
100 MHZ E.O. M
LASER
INPUT
J5M
J M
J9
J14
J7
VIDEO IN.
P.D. BIAS
P.D. SIGNAL
J6
J10
J11
INTERFACE
CONNECTOR
P.D. TEST
50Ω
START OF
BLANKING
J8
POWER CONNECTOR
DRIVE



TOLERANCES (EXCEPT AS NOTED)	conoptics INC. Danbury, CT 06810		
DECIMAL	IDENT. CODE 8Z 52837	SCALE	DRAWN BY: DKF APPROVED BY:
FRACTIONAL	TITLE: 100 MHZ INSTALLATION DWG		
ANGULAR	DATE: 11-19-85	DRAWING NUMBER: 100 009	S F

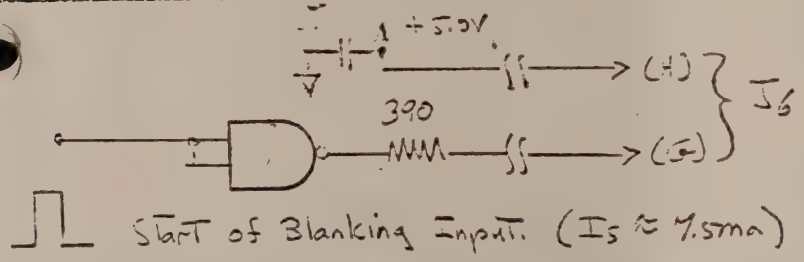
		REVISION RECORD	AUTH.	DR.	CK.

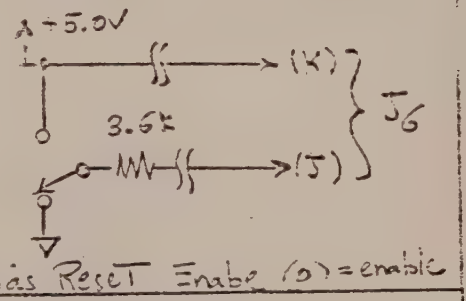
J6 Rear Panel

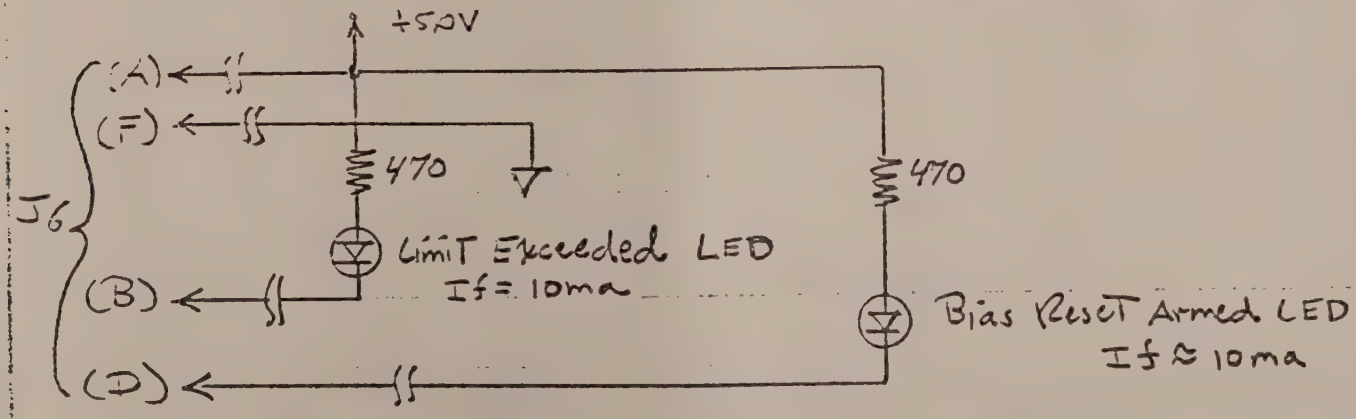
G = Start of Blanking
H = Vcc, Start of Blanking
J = Bias Reset Enable
K = Vcc, Bias Reset Enable
D = Bias Reset Armed
B = Bias Limit Exceeded
A = Ext +5.0V Supply
F = Opto-isolator Return.
C = Drive Electronics Gnd

J6 Pinout

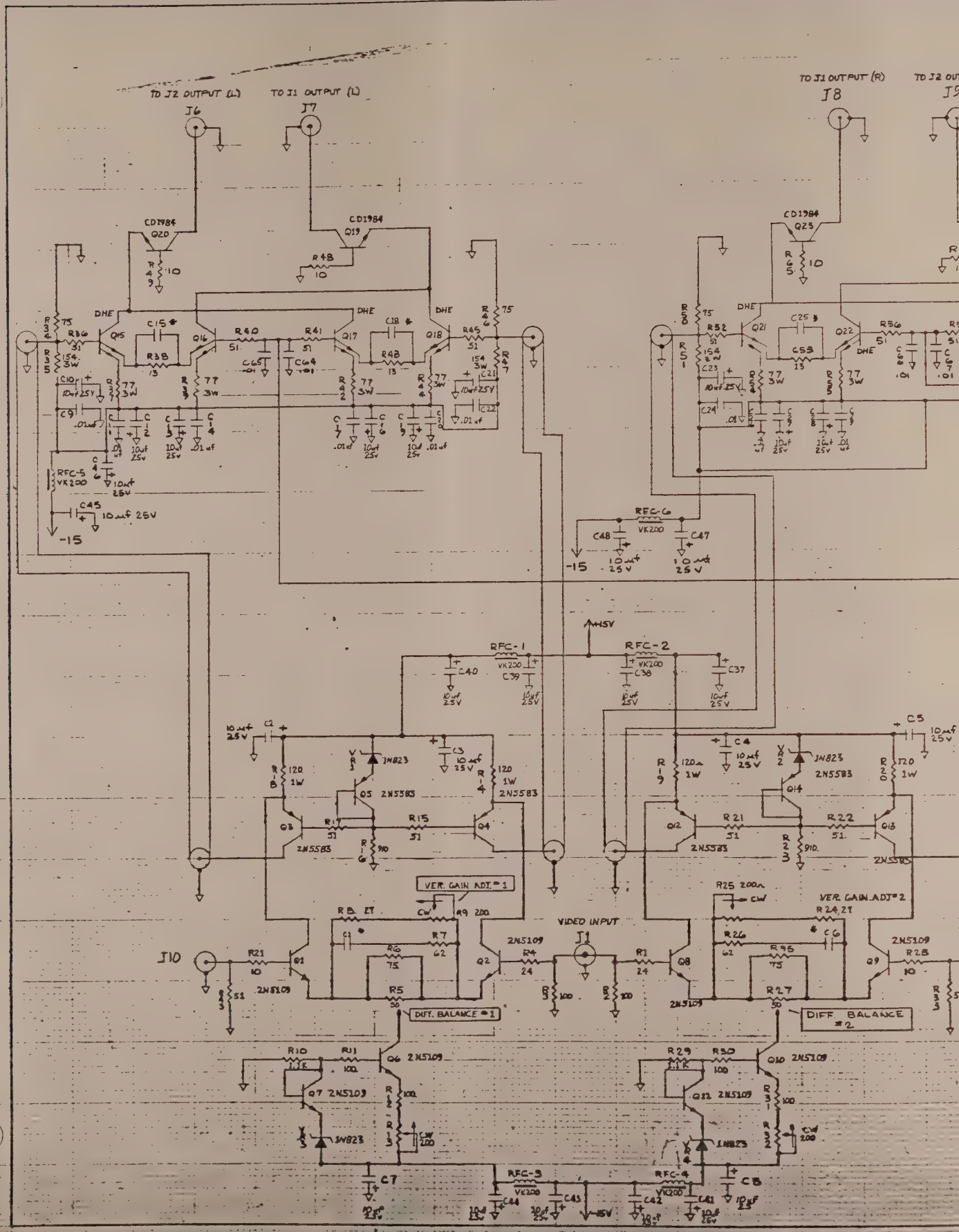
Typical Driving & Receiving Circuits

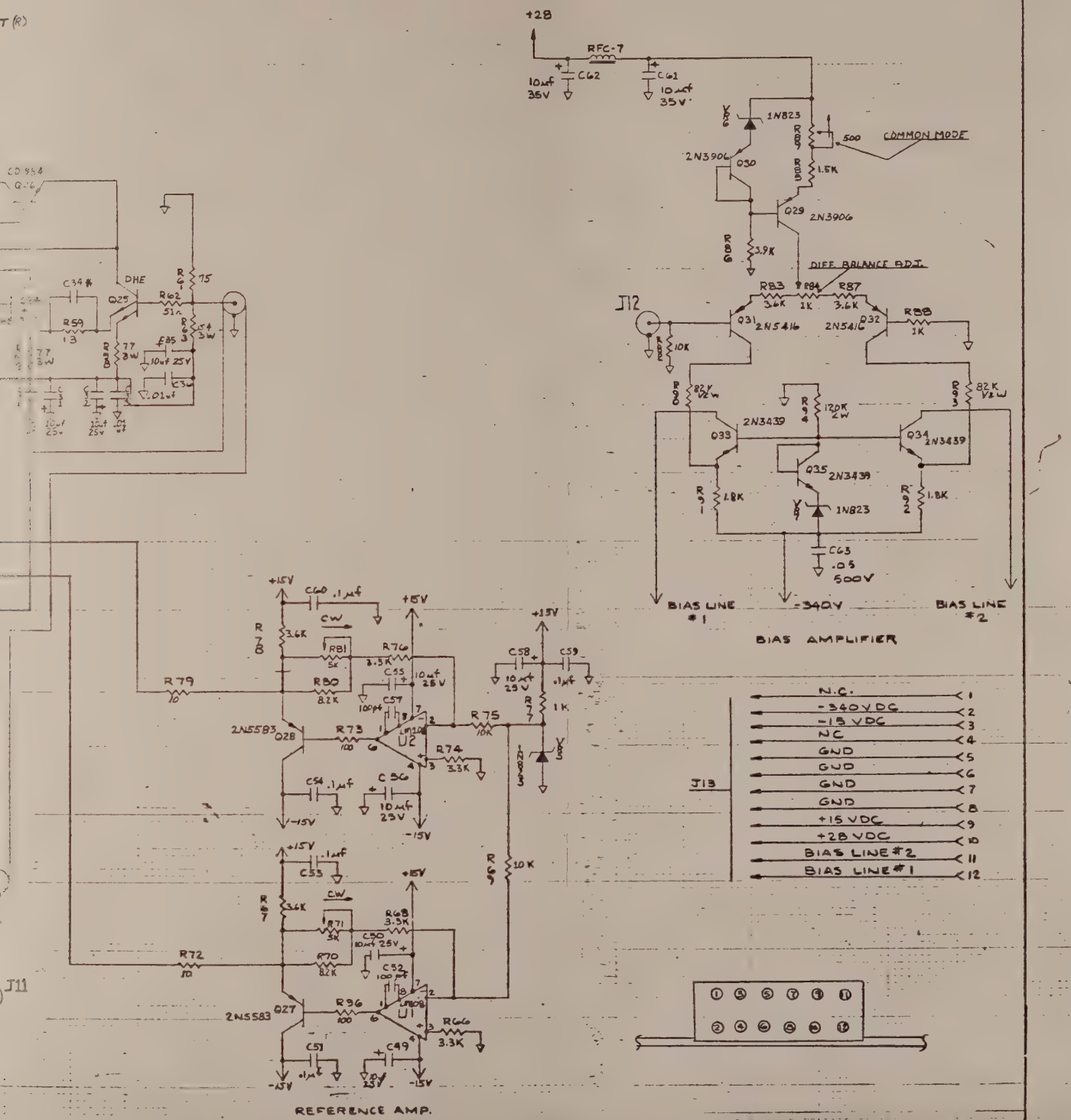






J6 Rear Panel Interface

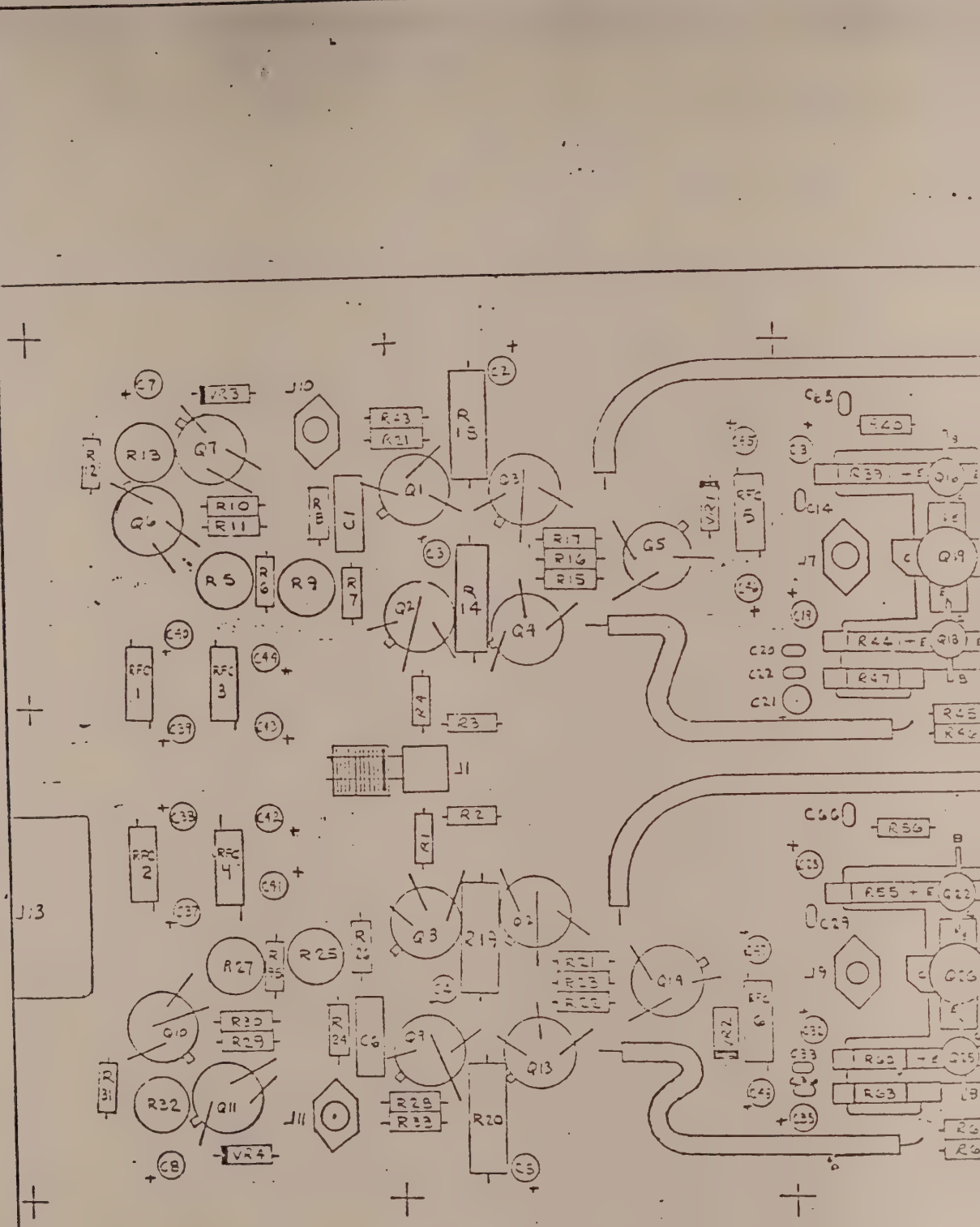

TO J2 OUTPUT (L)
TO J1 OUTPUT (L)
TO J1 OUTPUT (R)
J6
J7
J8
CD1984
Q20
Q19
Q23
R49 10
R48 10
R65 10
DHE
Q5
Q16
Q17
Q18
Q21
Q22
R34 75
R36 51
R38 13
R40 51
R41 51
R48 13
R46 75
R50 75
R52 51
R56 51
R53 13
R54 77 3W
R55 77 3W
R42 77 3W
R44 77 3W
R35 154 3W
R51 154 3W
C15 *
C18 *
C25 *
C65 .01
C64 .01
C21 10uf 25V
C22 .01 uf
C23 10uf 25V
C24 .01
C53 15
C9 .01uf
C10 10uf 25V
C16 10uf 25V
C17 .01uf
C19 10uf 25V
C20 .01uf
C12 10uf 25V
C13 10uf 25V
C14 .01uf
C66 10uf 25V
C67 .01
C68 10uf 25V
C69 .01
RFC-5 VK200
C46 10uf 25V
C45 10uf 25V
-15
RFC-6 VK200
C48 10uf 25V
C47 10uf 25V
+15V
RFC-1 VK200
RFC-2 VK200
C40 10uf 25V
C39 10uf 25V
C38 10uf 25V
C37 10uf 25V
C1 10uf 25V
C2 10uf 25V
C3 10uf 25V
C4 10uf 25V
C5 10uf 25V
R8 120 1W
R14 120 1W
R19 120 1W
R20 120 1W
1N823
2N5583
Q3
Q5
Q12
Q14
R17 51
R15 51
R21 51
R22 51
R16 910
R23 910
VER. GAIN ADJ #1
VER. GAIN ADJ #2
R8 ET
R9 200
R25 200
R24 27
VIDEO INPUT
J1
J10
2N5109
Q1
Q2
Q8
Q9
R21 10
R7 62
R6 75
R4 24
R1 24
R26 62
R95 75
R28 10
R5 50
R27 50
R3 100
R2 100
R33 51
DIFF. BALANCE #1
DIFF. BALANCE #2
R10 1K
R11 100
Q6
Q7
R29 1K
R30 100
Q10
Q11
R12 100
R13 100
R31 100
R32 100
R18 200
R24 200
C7
C8
RFC-3 VK200
RFC-4 VK200
C44 10uf 25V
C43 10uf 25V
C42 10uf 25V
C41 10uf 25V
-15V



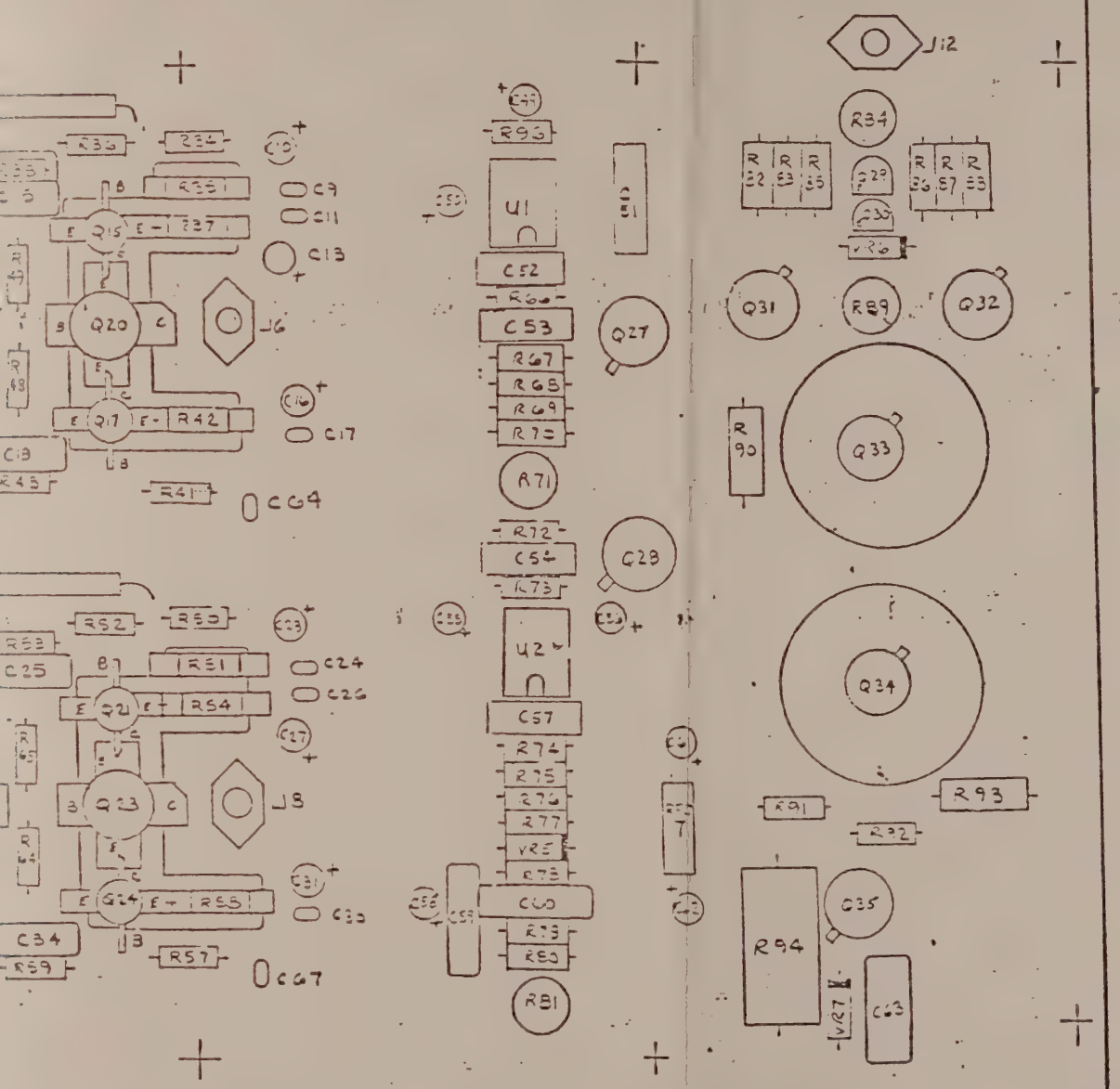
NOTES,

1. * TO BE DETERMINED AT TEST.
2. RESISTOR VALUES TO BE IN OHMS UNLESS OTHERWISE SPECIFIED.

TOLERANCES	conoptics INC. Danbury, CT 06810		
DECIMAL ± N/A	IDENT. CODE 82 528	SCALE NONE	DRAWN BY TBB
FRACTIONAL ± N/A	TITLE MOD 100 INPUT ELECTRONICS		
ANGULAR ± N/A	DATE 10/15/82	DRAWING NUMBER 100007	REV B

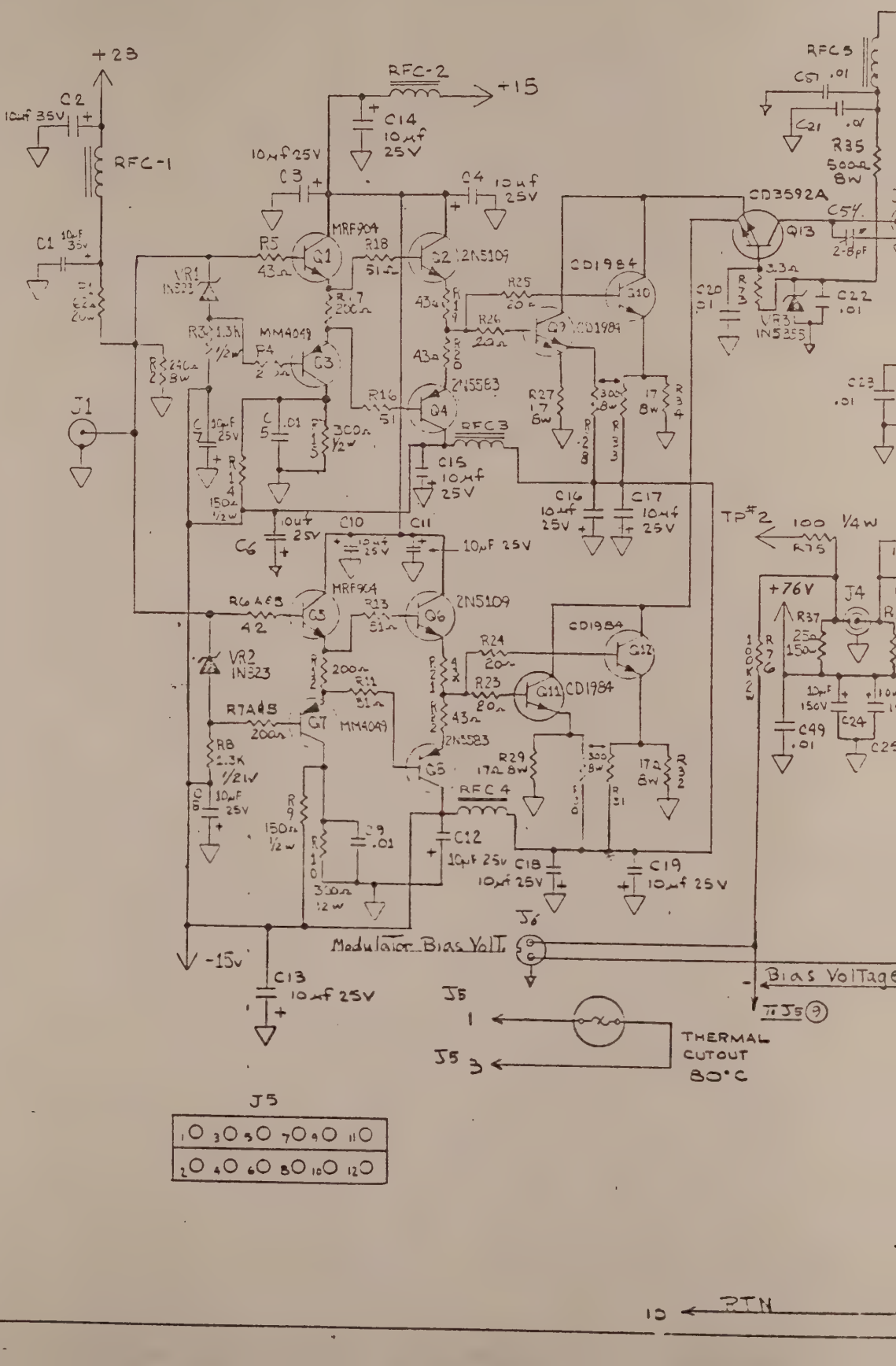

J10
J11
J13
VR3
VR4
VR1
VR2
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
Q15
Q16
Q17
Q18
Q19
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R23
R24
R25
R26
R27
R28
R29
R30
R31
R32
R33
RFC 1
RFC 2
RFC 3
RFC 4
RFC 5
RFC 6
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19
C20
C21
C22
C23
C24
C25
C26
C27
C28
C29
C30
C31
C32
C33
C34
C35
C36
C37
C38
C39
C40
C41
C42
C43
C44
C45
C46
C47
C48
C49
R37
R38
R39
R40
R41
R42
R43
R44
R45
R46
R47
R48
R49
R50
R51
R52
R53
R54
R55
R56

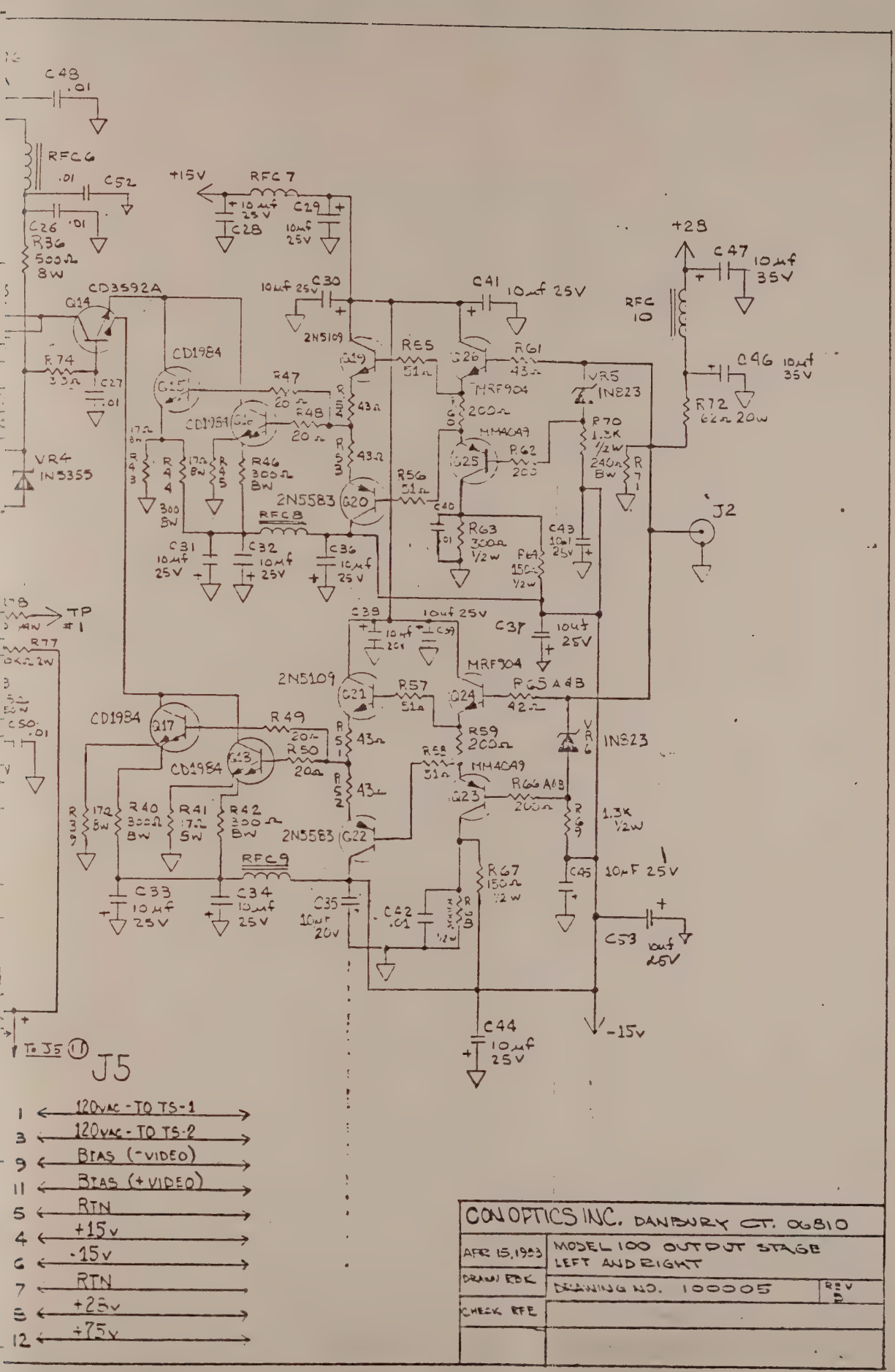
DATE	DWN	REVISION RECORD	AUTHORIZED
4-87	B	[illegible]	



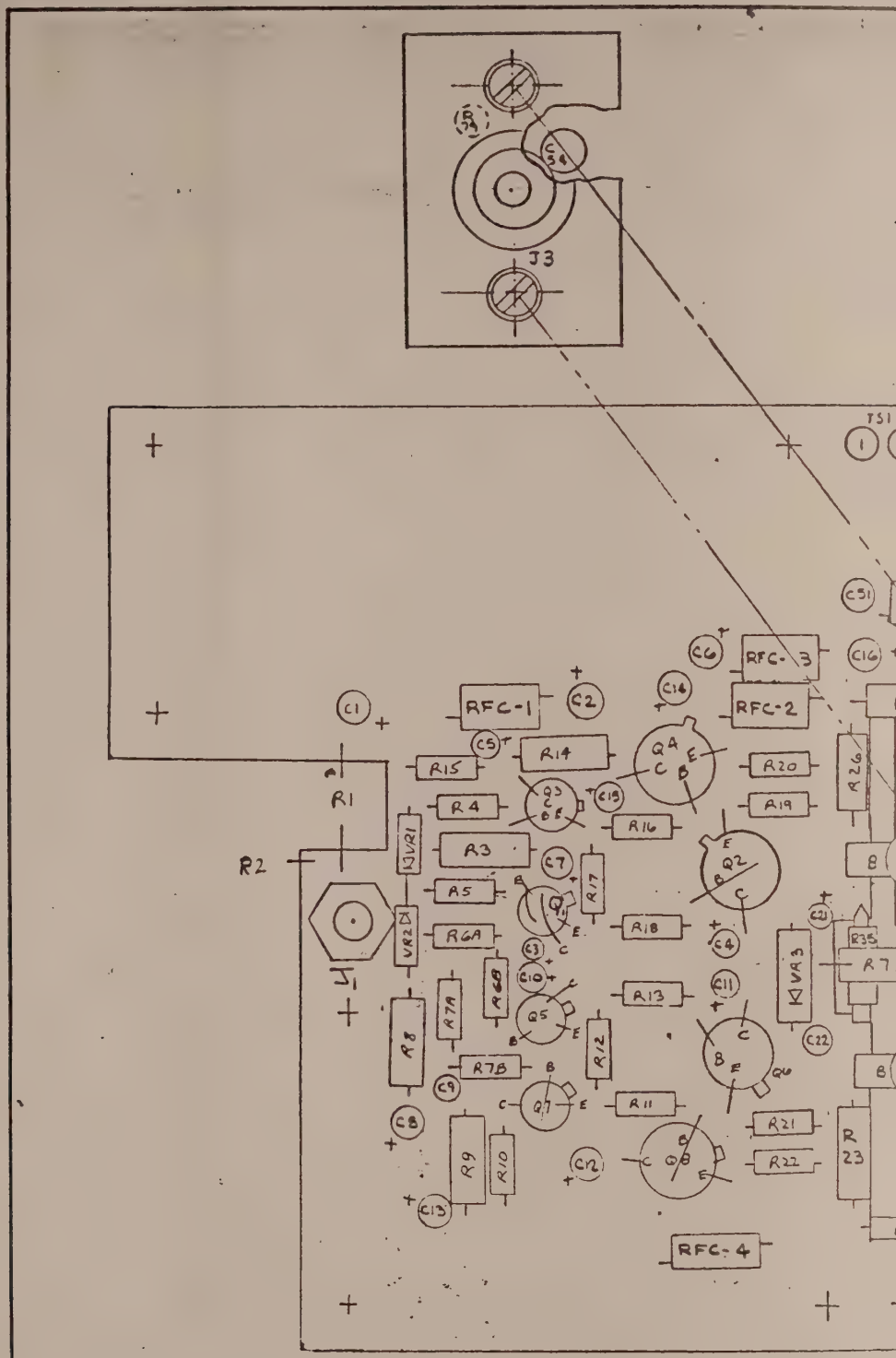
TOLERANCES UNLESS NOTED	CORoptics INC. Datour CT 06810		
DECIMAL ± N/A		SCALE N/A	DRAWN BY TBB
FRACTIONAL ± N/A	TITLE COMPONENT DIA - 100MHz INPUT EL.		
[illegible] N/A	4/7/87	100006	SHT 5

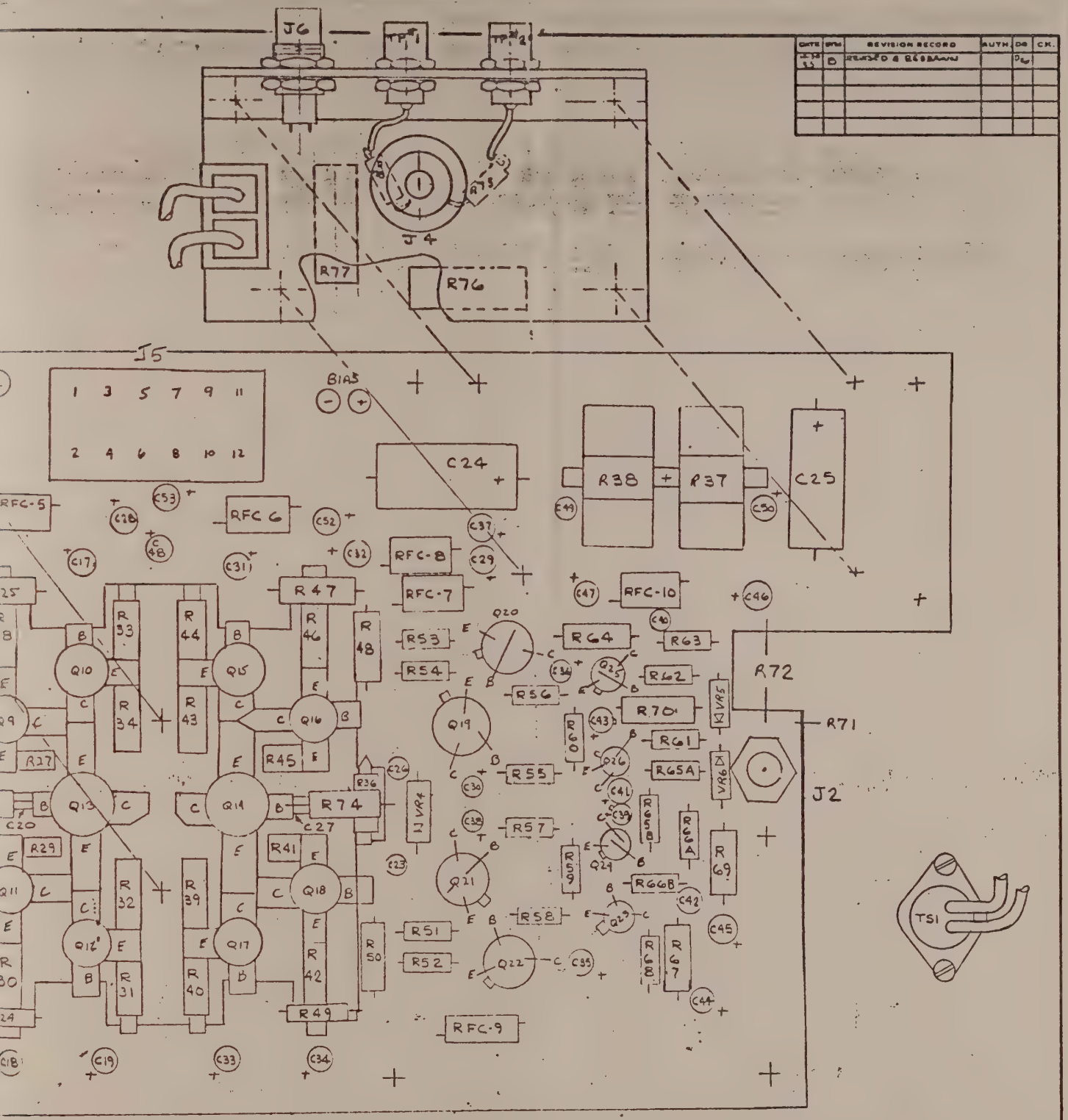
PAGE PLEA


+28
+15
RFC-1
RFC-2
C2
10uf 35V
C1 10pF 35V
C14 10uf 25V
C3 10uf 25V
C4 10uf 25V
MRF904
Q1
R5 43Ω
R18 51Ω
2N5109
Q2
VR1 IN523
R17 200Ω
R3 1.3K 1/2W
MM4049
Q3
P4 2 KΩ
R4 240Ω 2W
J1
C7 10pF 25V
C5 .01
R15 300Ω 1/2W
R16 51
2N5583
Q4
RFC3
C15 10uf 25V
C16 10uf 25V
C17 10uf 25V
C6 10uf 25V
C10
C11
10µF 25V
MRF904
Q5
R6 4.6Ω 4Ω
R13 51Ω
2N5109
Q6
VR2 IN523
R12 200Ω
R11 51Ω
R7 4.6Ω
200Ω
MM4049
Q7
R8 2.3K 1/2W
C8 10µF 25V
R9 150Ω 1/2W
R10 300Ω 2W
C9 .01
2N5583
Q8
RFC4
C12 10µF 25V
C18 10uf 25V
C19 10uf 25V
CD1984
Q9
Q10
Q11
Q12
R25 20Ω
R26 20Ω
R24 20Ω
R23 20Ω
43Ω
R27 17Ω 8W
R29 17Ω 8W
300Ω 8W
R28
R30
R31
R33
R34
R32
CD3592A
Q13
C54 1-8pF
C20 .01
R36 3.3Ω
VR3 IN5355
C22 .01
C23 .01
RFC5
C51 .01
C21 .01
R35 500Ω 8W
TP#2
R75 100 1/4W
+76V
J4
R37 25Ω 150Ω
100KΩ
C49 .01
C24
J6
Modulator Bias Volt.
Bias Voltage
TO J5 3
-15v
C13 10uf 25V
J5
1
3
THERMAL CUTOUT 80°C
J5
1 3 5 7 9 11
2 4 6 8 10 12
10 ← RTN



CONOPTICS INC. DANBURY CT. 06810	
APR 15, 1993	MODEL 100 OUTPUT STAGE LEFT AND RIGHT
DRAWN RDK	DRAWING NO. 100005 REV D
CHECK RFE	

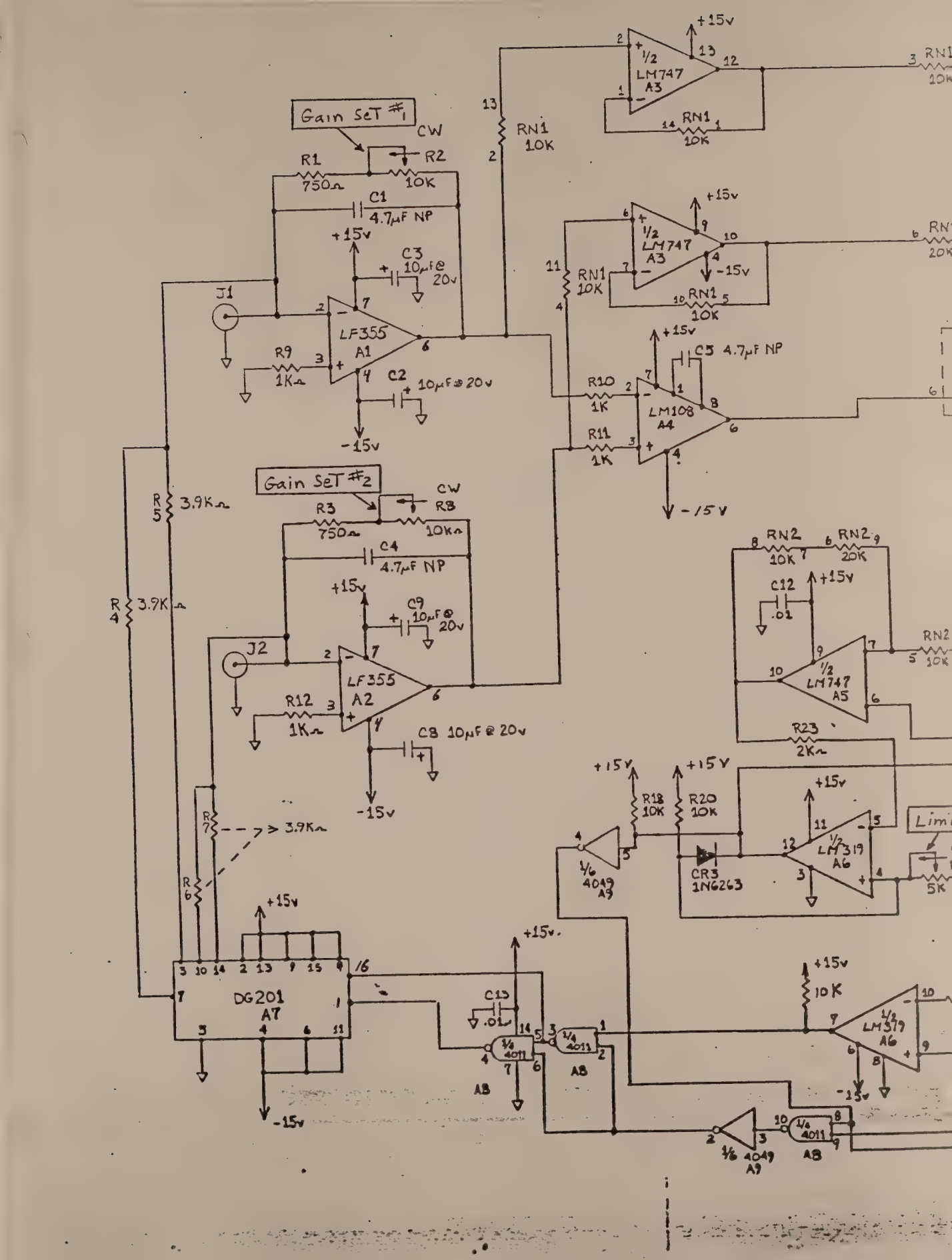

J3
C34
TS1
C1
C2
C5
C6
C14
C16
C51
RFC-1
RFC-2
RFC-3
RFC-4
R1
R2
R3
R4
R5
R6A
R6B
R7A
R7B
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R23
R26
R35
VR1
VR2
VR3
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
C3
C4
C7
C8
C9
C10
C11
C12
C13
C19
C22
E1

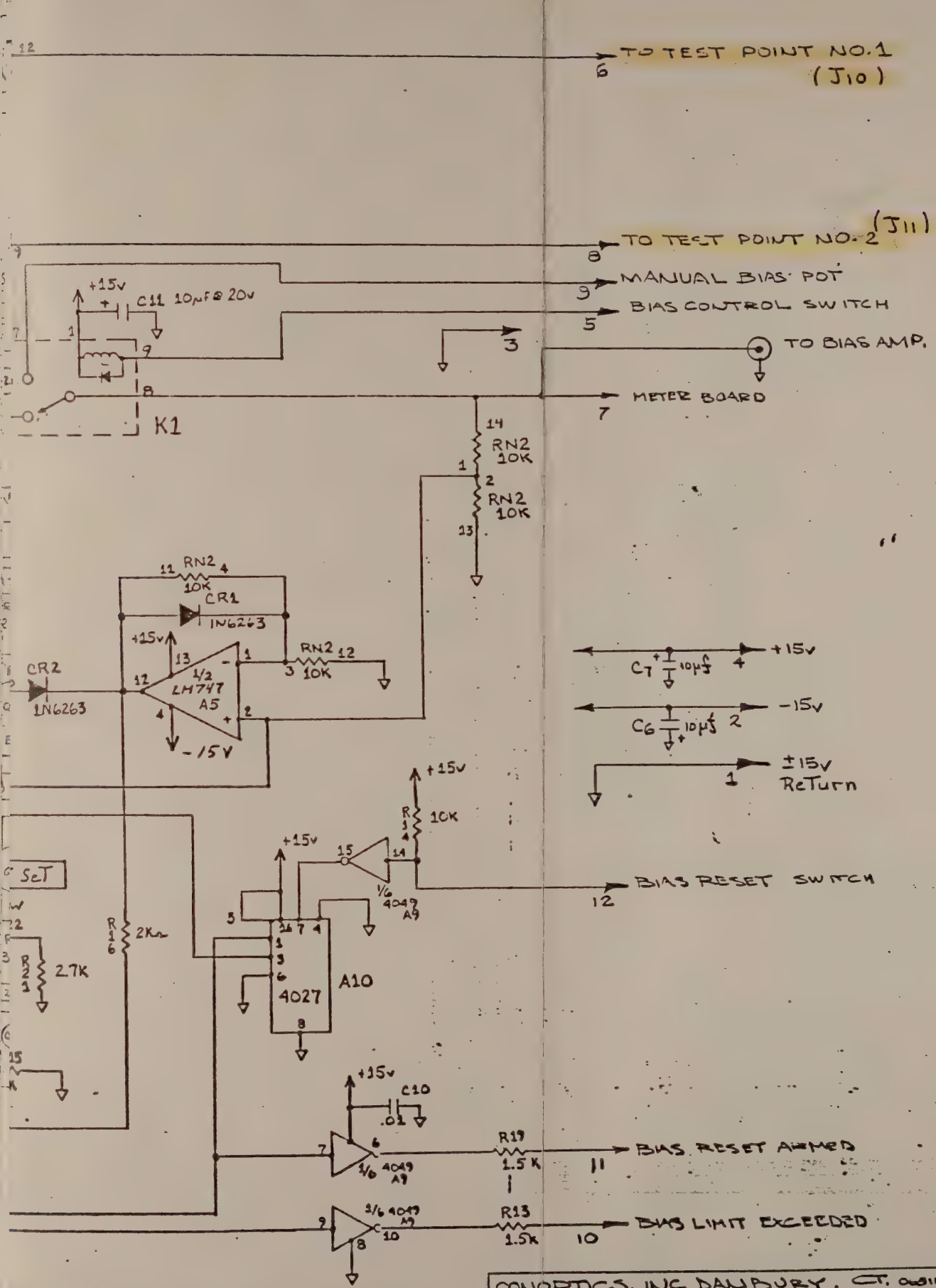


DATE	DWN	REVISION RECORD	AUTH.	DD	CK.
10/31/85	B	RELEASED & REDRAWN		DW	

TOLERANCES (EXCEPT AS NOTED)	CONOPTICS INC. DANBURY CONN. 06810		
DECIMAL ± N/A		SCALE 2	DRAWN BY / APPROVED BY
FRACTIONAL ± N/A	TITLE COMPONENT LAYOUT - 100 MHZ OUTPUT STAGE LEFT & RIGHT		
ANGULAR ± N/A	DATE 10/31/85	DRAWING NUMBER C 100,006	REV B

MADE IN U.S.A.

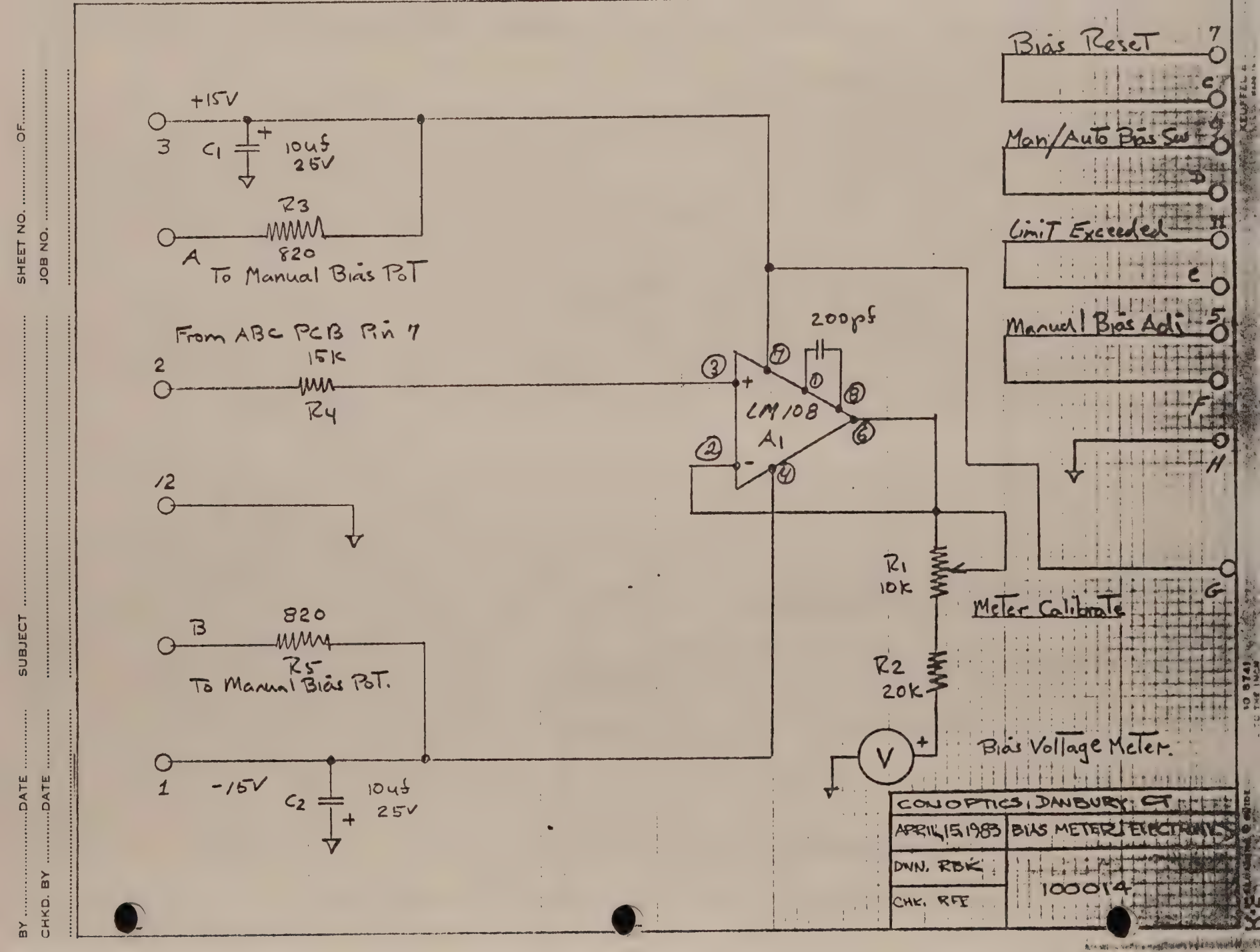

Gain SET #1
CW
R1
750Ω
R2
10K
C1
4.7μF NP
+15v
C3
10μF@ 20v
J1
LF355
A1
R9
1Kn
C2
10μF@20v
-15v
Gain SET #2
R3
750Ω
R8
10Kn
C4
4.7μF NP
C9
10μF@ 20v
J2
LF355
A2
R12
1Kn
C8 10μF@20v
R5
3.9Kn
R4
3.9Kn
R7
3.9Kn
R6
DG201
A7
RN1
10K
1/2
LM747
A3
-15v
C5 4.7μF NP
R10
1K
LM108
A4
R11
1K
RN2
10K
20K
C12
.01
1/2
LM747
A5
R23
2Kn
R18
10K
R20
10K
1/6
4049
A9
CR3
1N6263
1/2
LM319
A6
5K
C13
.01
1/4
4011
A8
10K



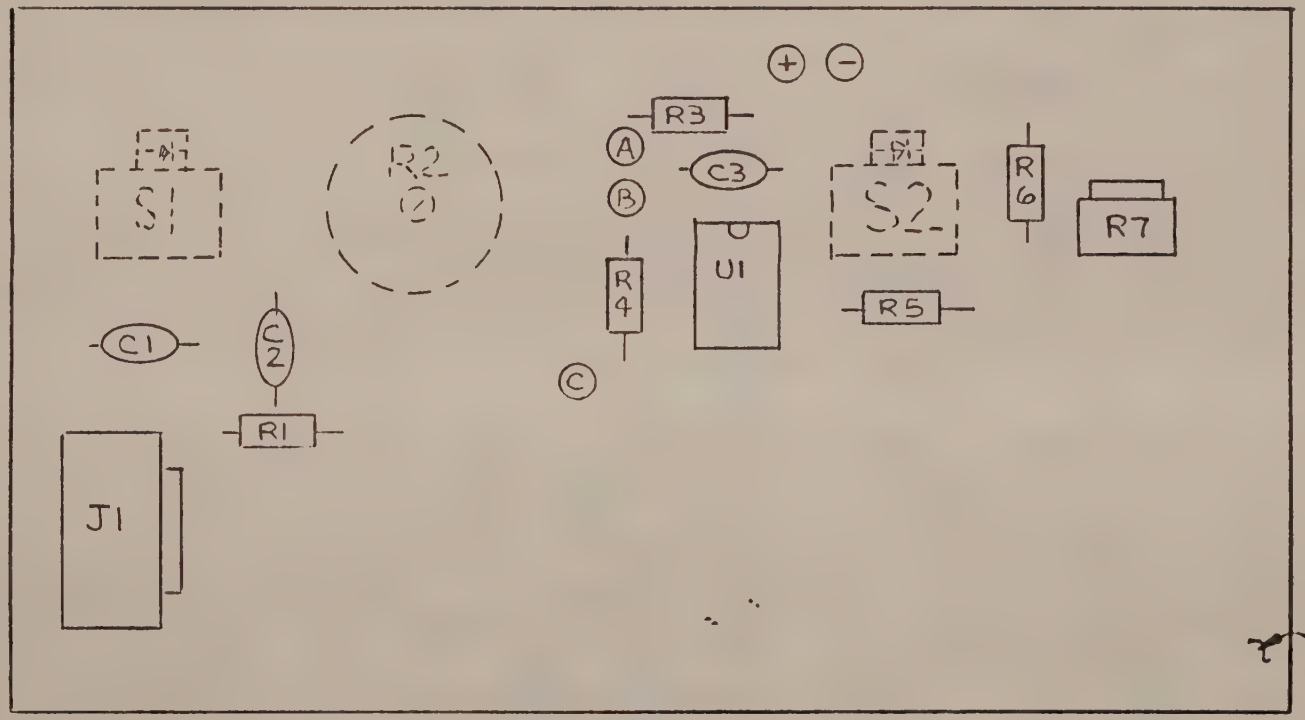
CONOPTICS, INC. DANBURY, CT. 06810

DATE 5-83 | CONTINUOUS AUTO BIAS CONTROL

MK. DAK


+15V
3
C1
10uf
25V
R3
820
A
To Manual Bias PoT
From ABC PCB Pin 7
2
15K
R4
12
B
820
R5
To Manual Bias PoT.
1
-15V
C2
10uf
25V
200pf
LM108
A1
Bias Reset
7
C
Man/Auto Bias Sw
9
D
Limit Exceeded
11
E
Manual Bias Adj
5
F
H
R1
10K
Meter Calibrate
G
R2
20K
V
Bias Voltage Meter.
CONOPTICS, DANBURY, CT
APRIL 15, 1983
BIAS METER/ELECTRONICS
DWN. RBK
CHK. RFE
100014.

DATE	SYM	REVISION RECORD	AUTH	DR.	CK.



1. COMPONENTS SHOWN WITH DASHED LINES ARE MOUNTED TO BOTTOM SIDE OF PC BOARD.

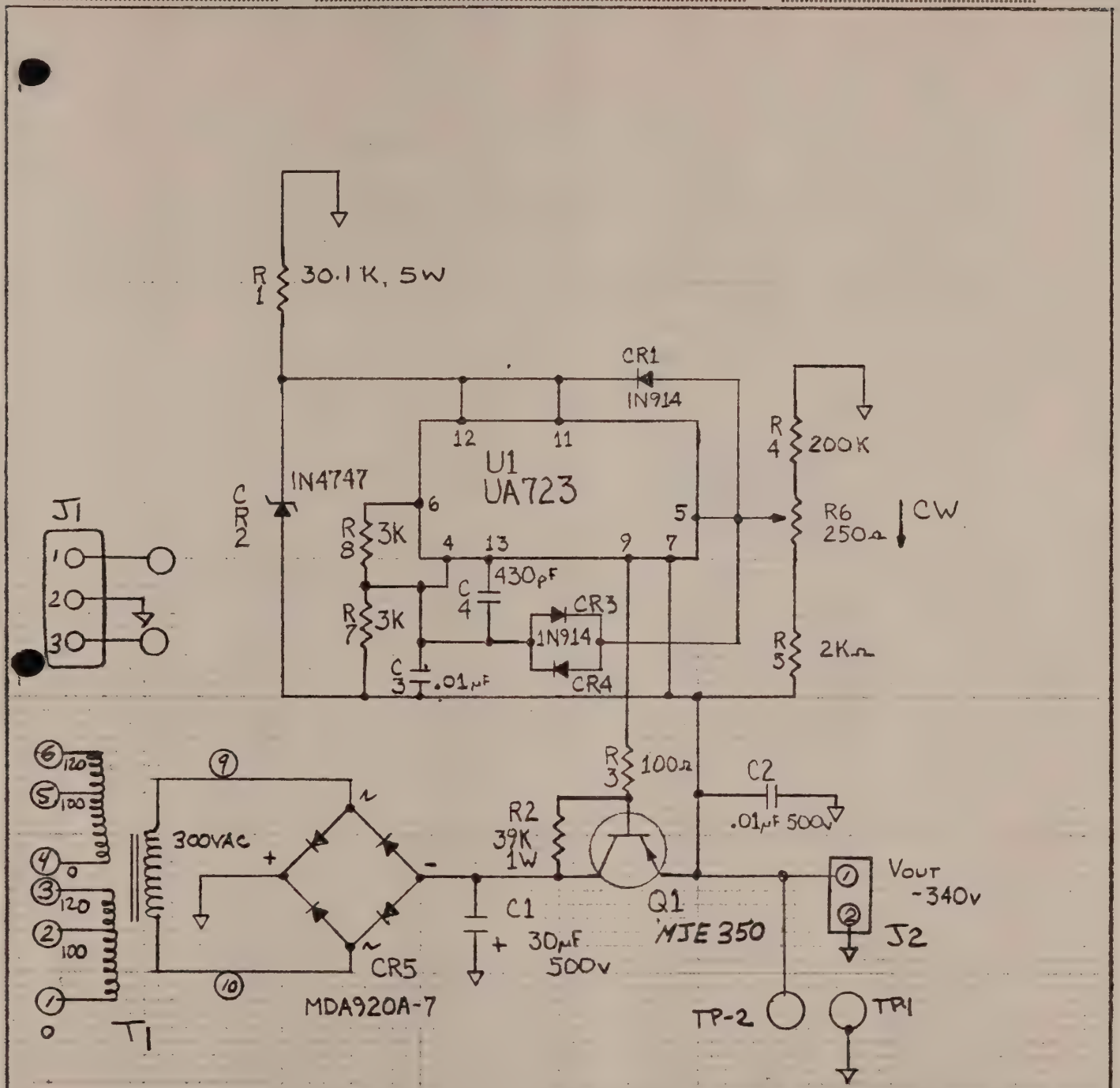
TOLERANCES (EXCEPT AS NOTED)			
DECIMAL ±		SCALE	DRAWN BY / APPROVED BY
FRACTIONAL ±	TITLE		
ANGULAR ±	DATE	DRAWING NUMBER	

K+E ALBANENE ® 10 5465 ENGINEERS' STANDARD FORM

MADE IN U.S.A.

BY .....DATE ..... SUBJECT ..... SHEET NO. ..... OF.....

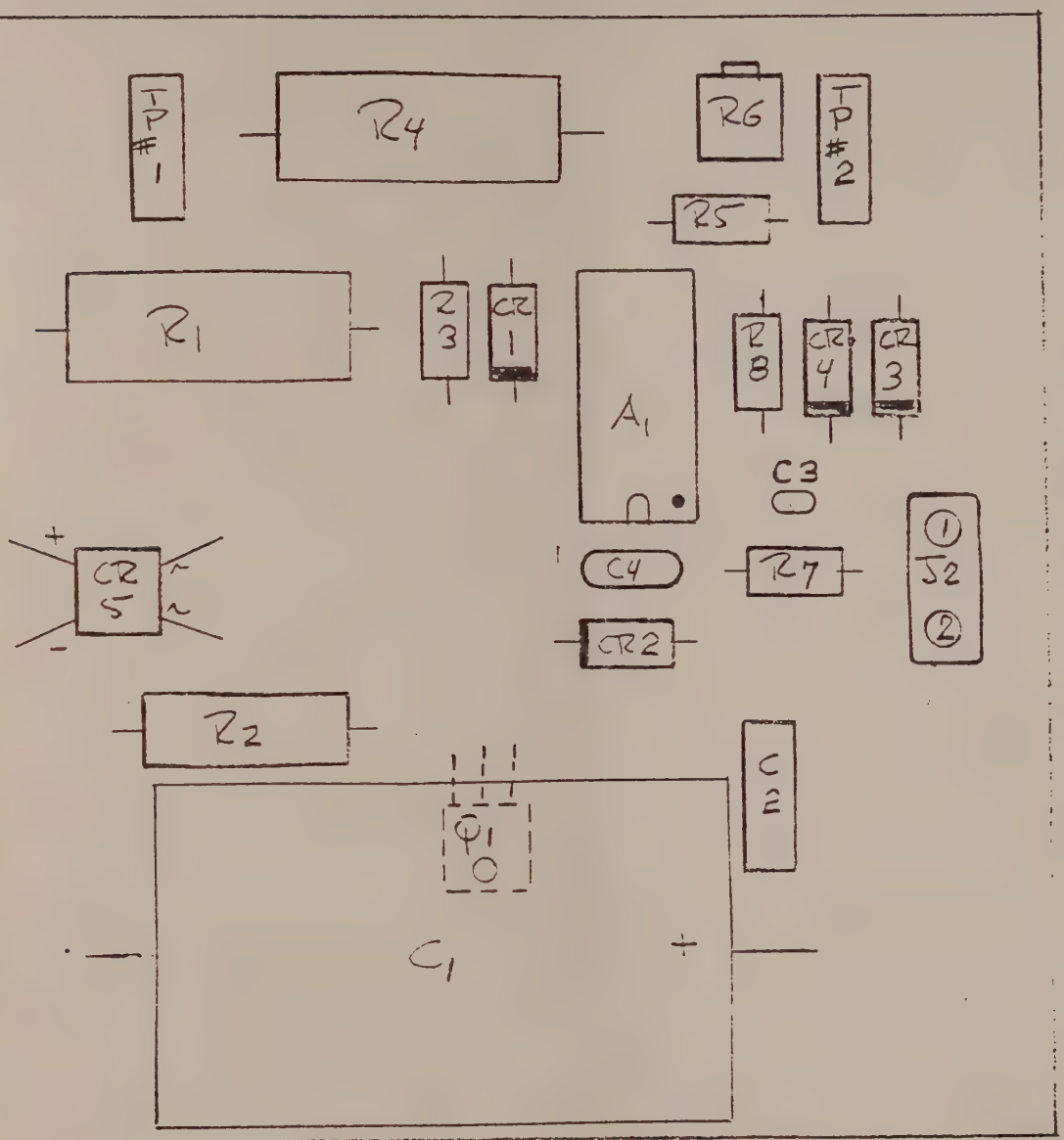
CHKD. BY .....DATE .... JOB NO. .....



CONOPTICS INC. DANBURY CT.	
5-9-83	-340V POWER SUPPLY
DWN. RBK	100012
CHK. RFE	Rev A

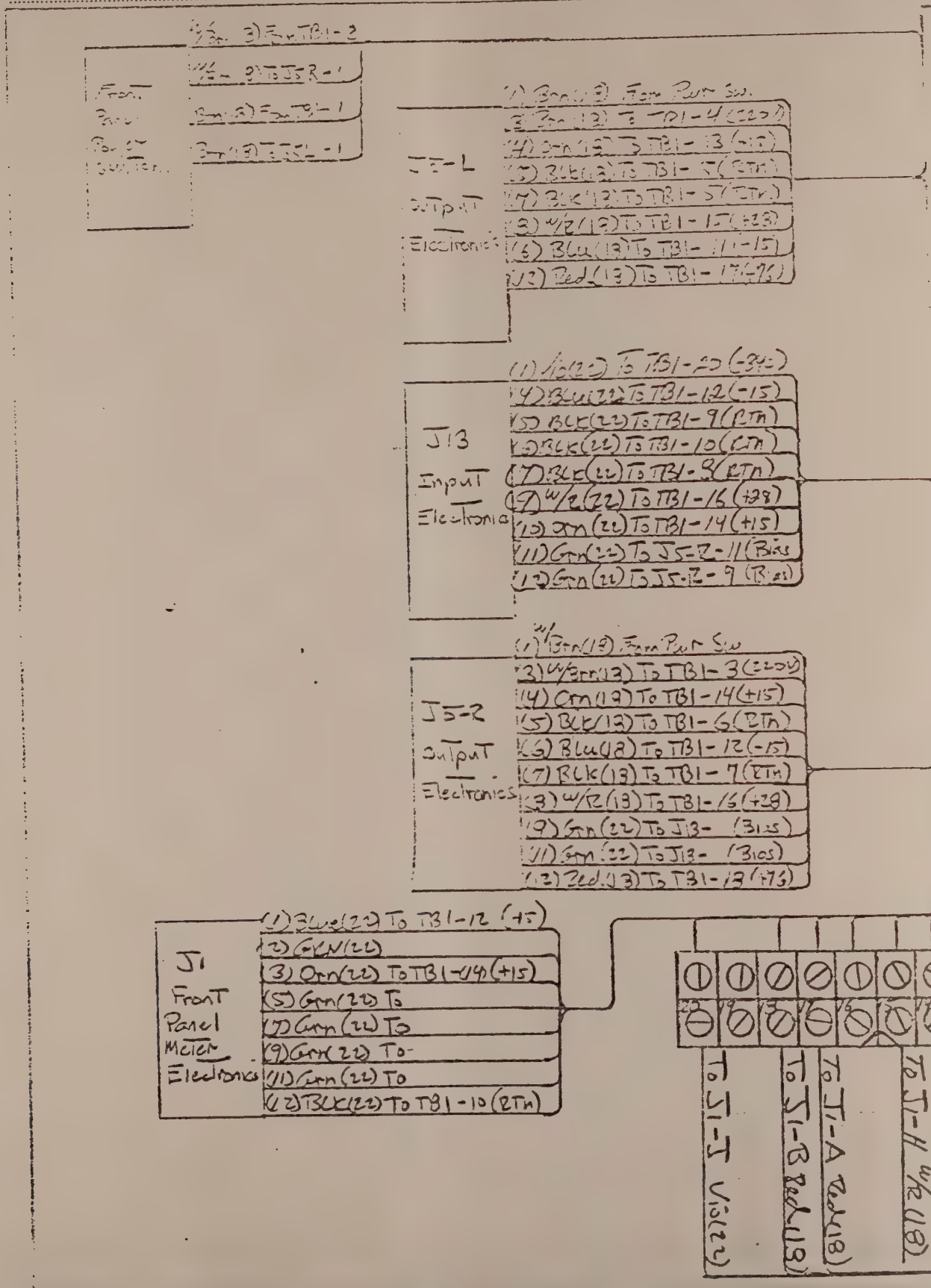
ALBANENE 5 GUIDE LINE 10 5741 10 X 10 TO THE INCH KEUFFEL & ESSER CO. MADE IN U.S.A.

J1
1
2
3
T1
1
2
3
4
5
6



CONOPTICS INC. DANBURY CT.	
	-340V P.S. COMPONENT DIA
	100013 Rev A

CHKD. BY ..... DATE ..... JOB NO. .....


Front Panel Meter Electronics
(3) Brn TB1-3
(9) To J5-R-1
(8) From TB1-1
(18) To TB1-1
J-1 Output Electronics
(1) Brn (18) From Pwr Sw.
(3) Brn (18) To TB1-4 (+20)
(4) Brn (18) To TB1-13 (-15)
(5) Blk (22) To TB1-5 (Eth)
(7) Blk (18) To TB1-5 (Eth)
(8) W/R (18) To TB1-15 (+28)
(6) Blu (18) To TB1-11-15)
(12) Red (18) To TB1-17 (+7V)
J13 Input Electronics
(1) Brn (22) To TB1-20 (-34)
(4) Blu (22) To TB1-12 (-15)
(5) Blk (22) To TB1-9 (Eth)
(6) Blk (22) To TB1-10 (Eth)
(7) Blk (22) To TB1-8 (Eth)
(8) W/R (22) To TB1-16 (+28)
(10) Grn (22) To TB1-14 (+15)
(11) Grn (22) To J5-R-11 (Bias)
(12) Grn (22) To J5-R-9 (Bias)
J5-R Output Electronics
(1) W/Brn (18) From Pwr Sw
(3) W/Brn (18) To TB1-3 (+20V)
(4) Grn (18) To TB1-14 (+15)
(5) Blk (18) To TB1-6 (Eth)
(6) Blu (18) To TB1-12 (-15)
(7) Blk (18) To TB1-7 (Eth)
(8) W/R (18) To TB1-16 (+28)
(9) Grn (22) To J13- (Bias)
(11) Grn (22) To J13- (Bias)
(12) Red (18) To TB1-18 (+7V)
J1 Front Panel Meter Electronics
(1) Blue (22) To TB1-12 (-15)
(2) GRN (22)
(3) Grn (22) To TB1-14 (+15)
(5) Grn (22) To
(7) Grn (22) To
(9) Grn (22) To-
(11) Grn (22) To
(12) BLK (22) To TB1-10 (Eth)
To J1-J Vio (22)
To J1-B Red (18)
To J1-A Red (18)
To J1-H W/R (18)

J1
Sampled
ABC

(1) (Blk 22) To TB1-5 (Ctr)
(2) Blk (22) To TB1-1 (-15V)
(3) Blk (22) To TB1-6 (Ctr)
(4) Grn (22) To TB1-3 (+15V)
(5) Grn (22) To J1 F.P. (9)
(6) Grn (22) To J1 F.P. (2)
(9) Grn (22) To J1 F.P. (5)
(10) Grn (22) To J1 F.P. (11)
(12) Grn (22) To J1 F.P. (7)

Amp
Conn

J7 To J8 18 To F.P. SOB.
J4 To J8 18 To F.P. P.D. Test
J3 To J8 18 To F.P. P.D. Sig
J5 To J8 18 To Driver

J2
Sampled
ABC

(1) Grn (22) To J6-1 (Ctr 0V)
(2) Grn (22) To J6-2 (Lim T)
(4) Grn (22) To J6-4 (Armed)
(5) Grn (22) To J6-6 (Rel T)
(7) Grn (22) To J6-7 (SOB)
(8) Grn (22) To J6-8 (Sup Vcc)
(9) Grn (22) To J6-9 (Test T)
(10) Grn (22) To J6-10 (Test Vcc)

J5

Fan #1

220V From TB1-3
220V From TB1-4

Fan #2

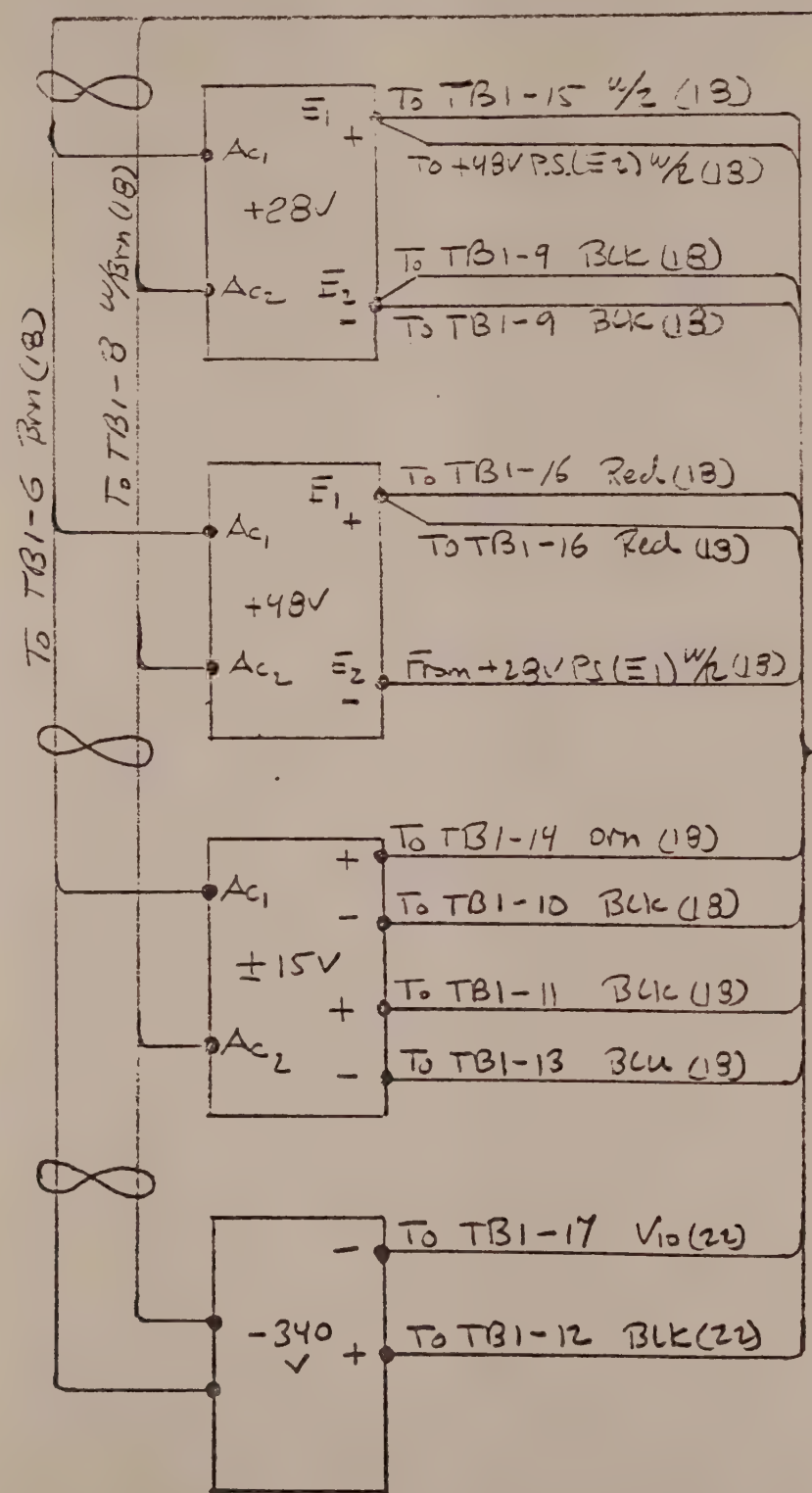
220V From TB1-3
220V From TB1-4

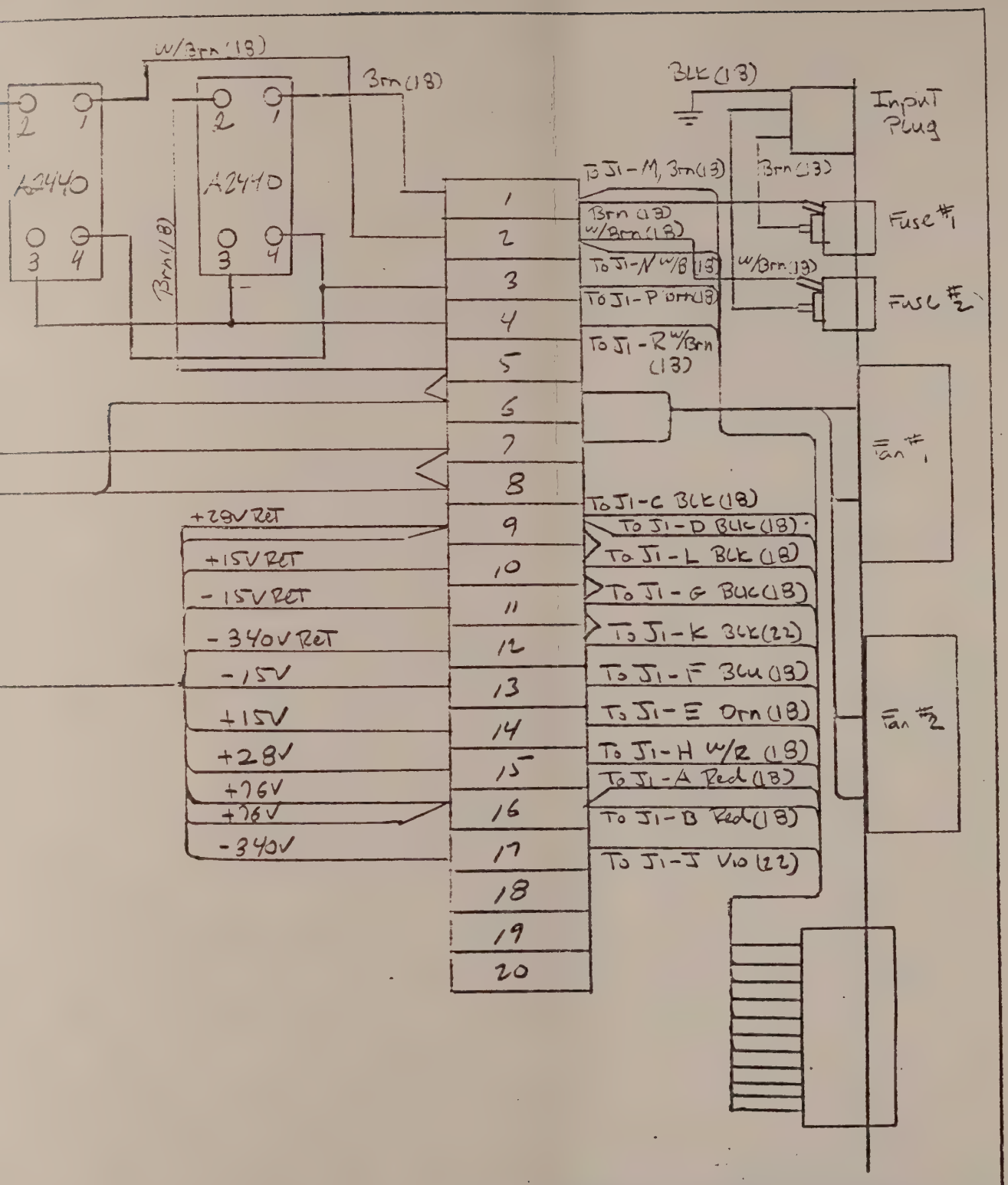
J8

To J8-M Brn (18)
To J8-N W/Brn (18)
To J8-P Brn (18)
To J8-E W/Brn (18)
To J8-C Blk (18)
To J8-D Blk (18)
To J8-L Blk 18
To J8-G Blk 18
To J8-K Blk (22)
To J1-F Blu (18)

BY .....DATE ..... SUBJECT ..... SHEET NO. ..... OF .....

CHKD. BY .....DATE ..... JOB NO. .....





CONOPTICS INC. DANBURY CT	
ENG. RC	100 MHz - GAC P.S. WIRING
Ck.	
Drawn By	

BY ..... DATE .....
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SUBJECT .....

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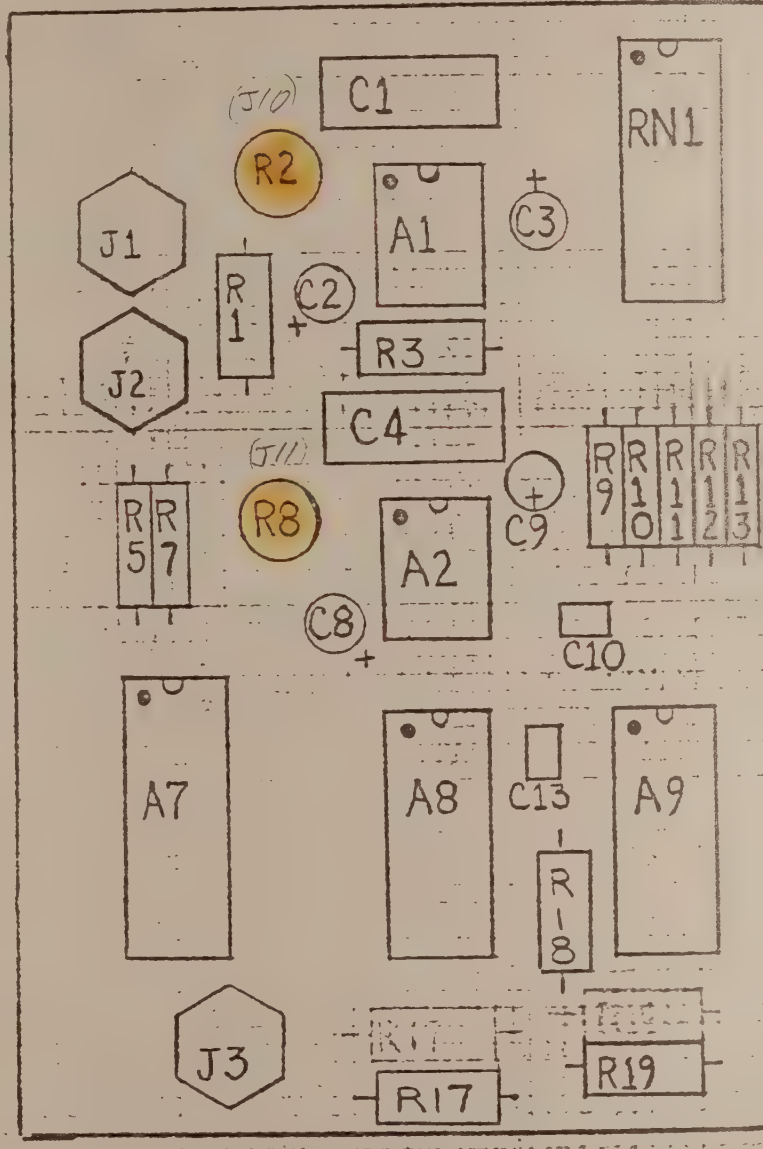

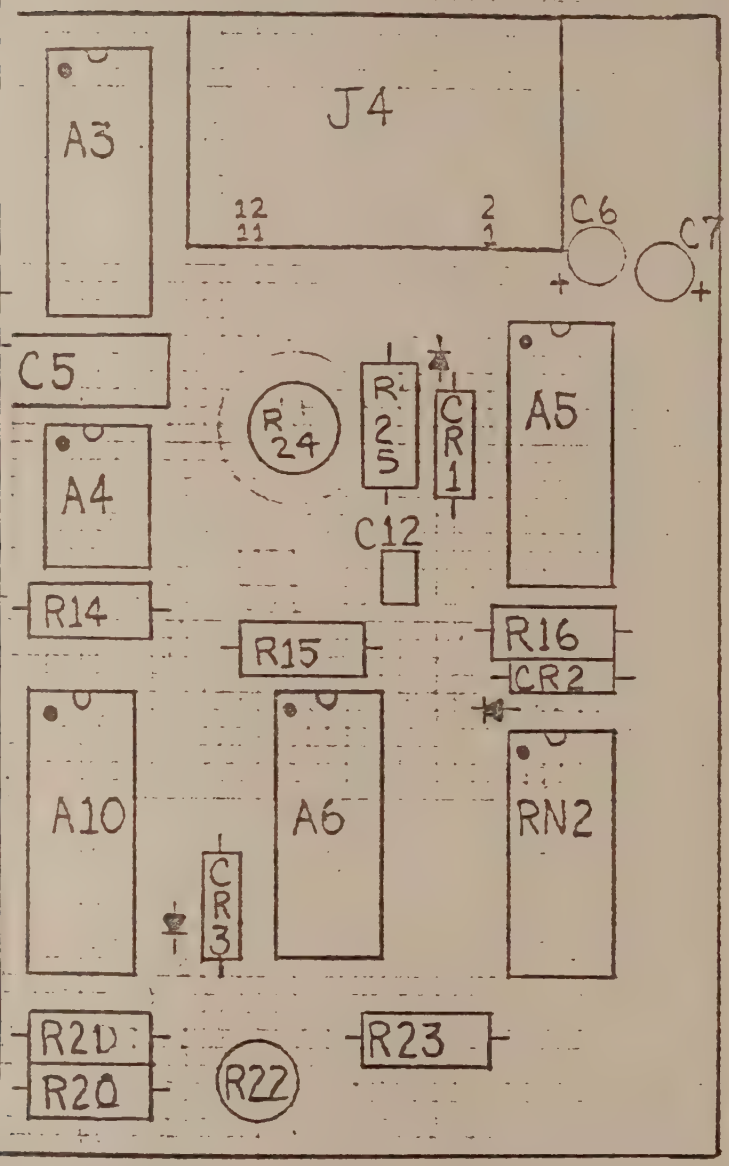

CONOPTICS INC. DANBURY CT. 06810	
APR.15,1983	COMPONENT LAYOUT CONTINUOUS AUTO BIAS
DWN. RBK	DRAWING NO. 100019
CHK. RFE	LASER OPTIC MODULATION SYS.

POWER SUPPLY
INSTRUCTION MANUAL

MODEL RJD212

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RJD DUAL
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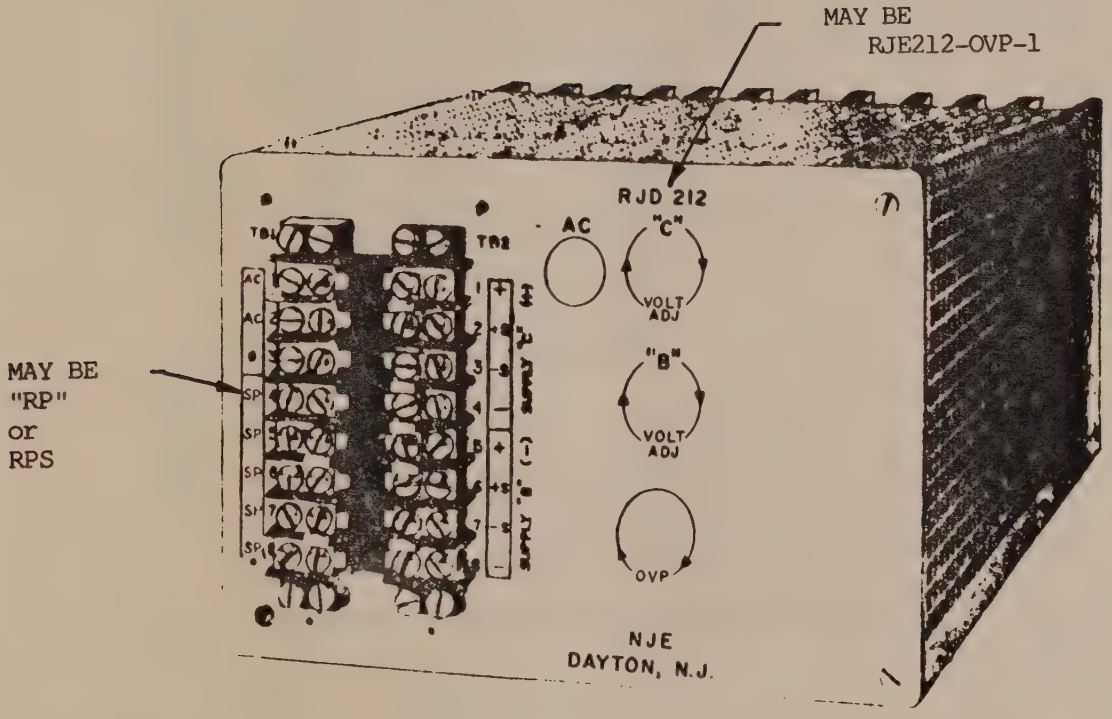

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SECTION I

THEORY OF OPERATION

1-1. GENERAL DESCRIPTION.

The NJE RJ dual line of modular power supplies are tracking type two output power supplies (negative output tracking positive output). They may be wired at the factory to provide two isolated and independently regulated outputs, each with its own OVP. The circuitry is all silicon solid state and includes the utilization of integrated circuits. Additionally, all supplies are series regulated and are manufactured with high quality industrial grade components. The quality of the power supply is intended to be consistent with that required for the most sophisticated and/or expensive electronic system in use today. The circuits used are extremely reliable and feature a high degree of simplification. The circuit simplification results in standardization of material and also gives greater reliability due to the reduction of components used in the basic circuits. The overall design philosophy utilized in this product line is based on standardization, simplicity, reliability, and high quality.

1-2. FEATURES.

The NJE RJ dual power supplies provide many features which provide the user with the maximum flexibility consistent with competitive cost, simplicity of design and long term reliability. These features include the following:

1-2-1. OVER VOLTAGE PROTECTION (OVP): (Optional) SCR crowbar to limit maximum output voltage. Normally factory set at 33V (±16.5V).

1-2-2. CURRENT LIMITING: Current limiting is set to limit maximum current to approximately 125% of rated current.

1-2-3. REMOTE SENSING: Sensing terminals separate from the load terminals provide regulation of the voltage at the load rather than regulation of the voltage at the power supply output terminals. This eliminates the loss of load regulation due to the voltage drop in the wires connecting the supply to the load.

1-2-4. AC INPUT: All units are designed to operate from 47 HZ to 440 HZ. Input voltage range is 105 to 125 volts and optionally available is 210 to 250 volts AC. 50 HZ consult factory.

1-2-5. FAULT PROTECTION: The power supplies are protected with primary fuses.

1-3. COOLING.

All power supplies are convection cooled and will meet published specification without any additional heat sink and/or forced air cooling.

1-4. DETAILED CIRCUIT DESCRIPTION.

Each module in the RJ dual line is similar in circuit structure and each output may be represented by five functional blocks. (See Figure 1).

A. Transformer

B. Bias Circuit - 1) Rectifier and Filter
2) Regulator IC

C. Main Circuit - 1) Rectifier and Filter
2) Series Regulator
3) Driver

D. Current Sensing and Limiting Circuit

E. Over Voltage Protection (OVP)

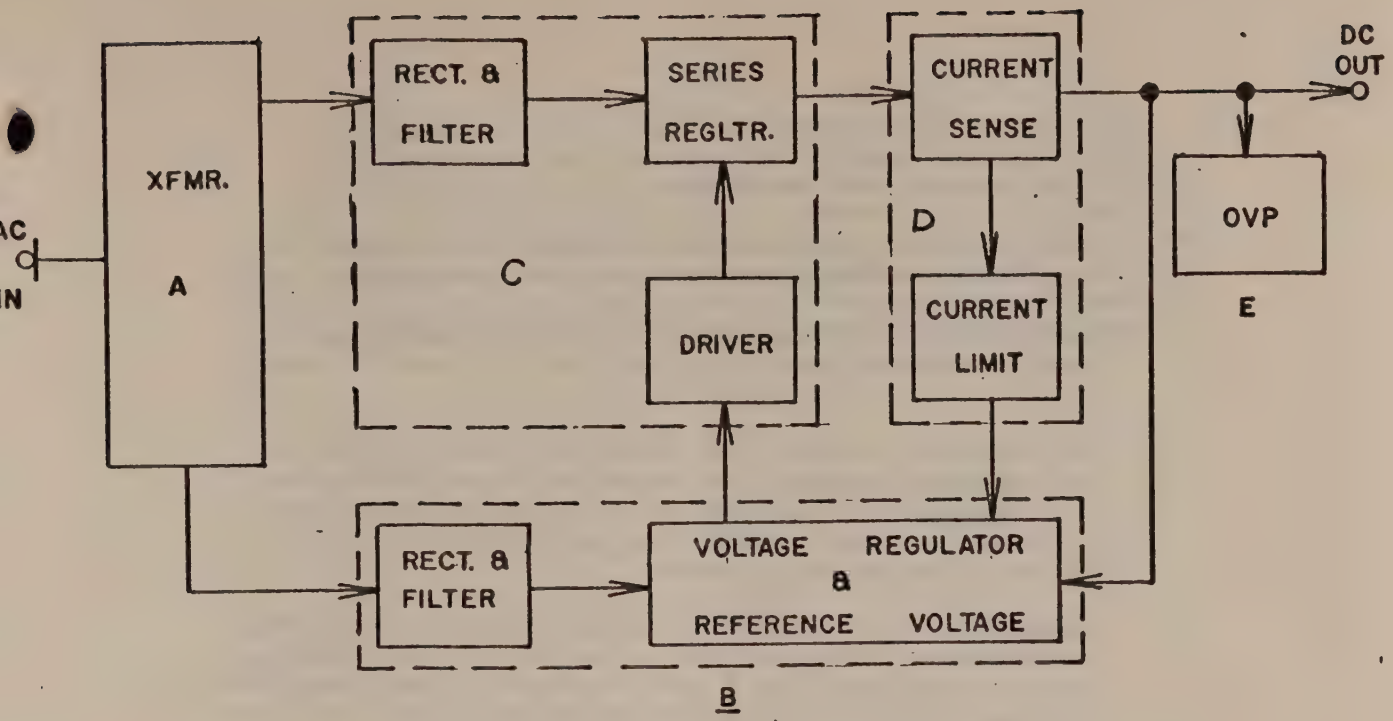
1-4-1. TRANSFORMER: Each transformer section has a 115V winding, electrostatic shielding, and appropriate power windings. The power windings provide the proper voltage and current for the particular rectifier/filter combination used in the supply.

1-4-2. BIAS CIRCUIT: This section of the supply consists of a full wave rectifier, a capacitor filter and a zener diode regulator.

The equivalent circuit (Figure 2) of the IC regulator shows four (4) basic circuits within the package.

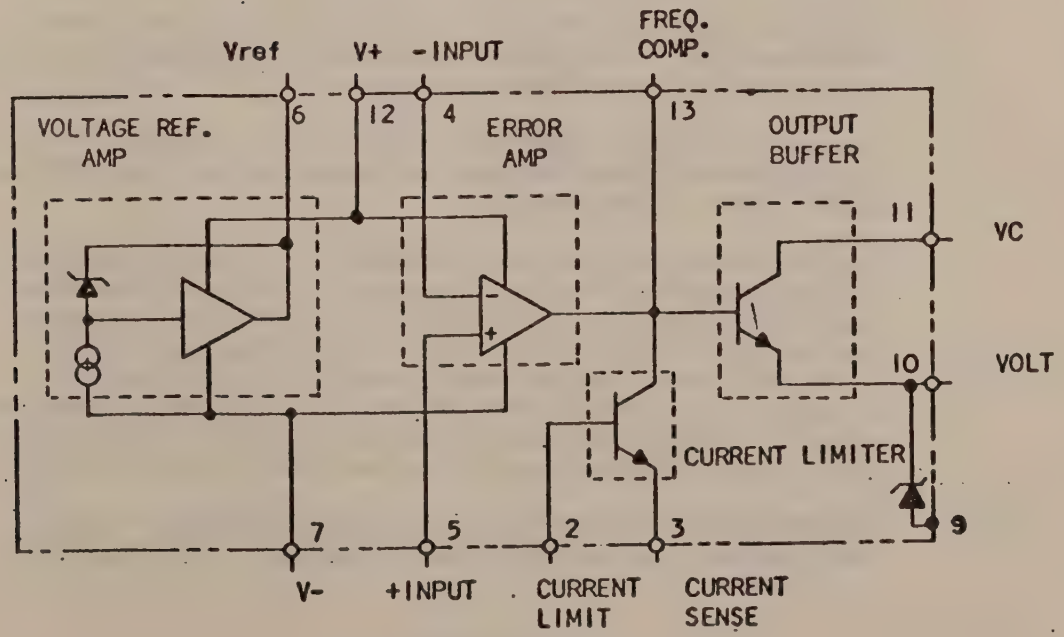
1) A reference voltage source
2) A differential error amplifier

(continued on Page 1-4)



BASIC BLOCK DIAGRAM (FOR ONE OUTPUT)

FIGURE 1



(TYPE 723)
REGULATOR IC SCHEMATIC
FIGURE 2

3) An output buffer
4) A current limit amplifier

The reference voltage for the positive output is derived from the reference voltage source of the integrated circuit.

Resistors R11C, R9C, and R10C form a divider network providing the output proportional voltage for the error amplifier of the positive output.

Resistors R12B and R4B form the divider network providing the reference voltage of the negative output. R3B is not used. Resistors R10B, R14B, and R11B form a divider network providing the output proportional voltage for the error amplifier of the negative output.

The error amplifier amplifies the voltage difference between the reference voltage and the output proportional voltage. The error amplifier output acts, through a current amplifier, to adjust the pass transistor(s) drive until the output proportional voltage equals the reference voltage.

1-4-3. MAIN CIRCUIT: This section is a full wave rectifier filtered by a capacitor and regulated by means of a series regulator Q2B and Q2C. Depending on the power requirements, the series regulator consists of one or more NPN silicon power transistors connected in parallel with each pass transistor having an emitter resistor.

The error signal of the IC regulator is current amplified by Q1B and Q1C. This amplified signal is utilized to control the output of the series regulator.

1-4-4. CURRENT SENSING AND LIMITING CIRCUIT: This section of the supply becomes effective when the output current reaches the preset limit of the supply.

The limit amplifier, an integral part of the IC voltage regulator, turns on, reducing the output voltage of the error amplifier of the IC. This results in limiting of the power supply output current. The limiting of output current results in a corresponding reduction of output voltage and increased limiting of current (foldback), which insures against excessive power dissipation in the series pass transistor(s). Both the positive and negative outputs have current limiting.

1-4-5. OVERVOLTAGE PROTECTION: All power supply units utilize a PNP transistor as an SCR driver. The base of the transistor

is biased by a resistor divider network consisting of R20A, R22A, and R21A from the output of the power supply. The emitter has a 6.0 volt zener in series with the supply output. When the output voltage increases to a level equal to the sum of the zener voltage plus the transistor base emitter voltage, the transistor turns on and fires the SCR crowbar shorting the power supply output terminals. Simultaneously the current limiting circuitry reduces the output current.

SECTION II

OPERATION

PLEASE READ THESE INSTRUCTIONS BEFORE OPERATING THE SUPPLY

2-1. UNPACKING AND INSPECTION.

Temporarily save all packing material. Read and save all instruction material. Inspect the physical condition of the unit for possible shipping damage. Particularly look for broken controls, fuse holders, and dents, loose hardware and missing parts. Do not operate the unit if obvious or suspected mechanical damage has occurred.

2-2. ADJUSTMENTS.

To place the supply in operation, connect a suitable load to the indicated load terminals with the sensing leads either jumpered to the output terminals at the supply (as when the unit is shipped) or connected remotely at the load (observe polarity).

NOTE

Sensing leads must never be left disconnected.

Apply AC power to the indicated terminals. Output adjustment is achieved by a pot adjustment through an appropriately marked hole in the unit.

Over voltage protection is factory set at 33V (±16.5V).

2-3. CONNECTIONS.

The units have barrier strip terminals for input and output connections. The positive or negative output terminal may be grounded or operated floating up to a maximum of 500 volts with respect to chassis.

NOTE

1. Output terminals of power supply should never exhibit a reverse voltage. A protective diode is connected across the power supply outputs.

2. For tracking dual supplies, there must always be a common jumper between the negative output of the positive supply and the positive output of the negative (tracking) supply.

2-3-1. REMOTE SENSING: The unit has provisions whereby the output voltage may be regulated directly at the load terminals. Under heavy loads poor regulation may occur at the load due to the voltage drop in the load leads if remote sensing is not used. Shielded wires should be used for connections between remote load and sensing terminals on power supply. Wire of sufficient size should be used for load leads to minimize voltage drop in these leads. See Figures 4 and 6 for remote sensing connections; for local sensing, see Figures 3 and 5.

2-4. TEST SETUPS AND CONNECTION DIAGRAMS

(See page 2-3)

2-5. MOUNTING.

When mounting the unit in an installation, care must be taken to provide sufficient air ventilation. The rating chart (Table 1, Page A2) shows output currents at ambient temperatures. The ambient temperature is defined as the temperature one inch from each surface of the supply, excluding the top.

4. TEST SETUPS AND CONNECTION DIAGRAMS

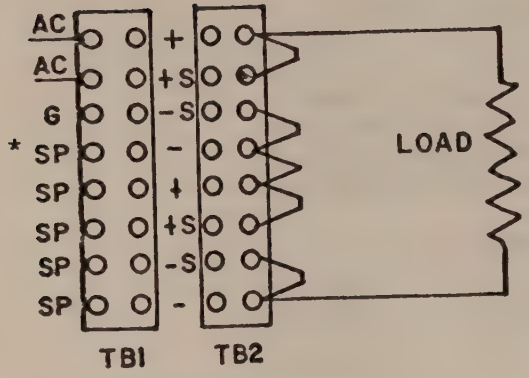


FIG. 3
LOCAL SENSING
COMMON LOAD

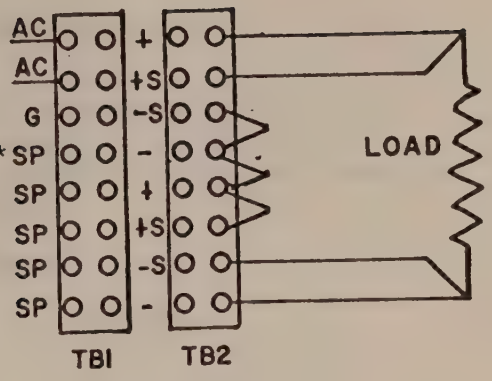


FIG. 4
REMOTE SENSING
COMMON LOAD

* MARKING MAY BE RP, RPS OR SP

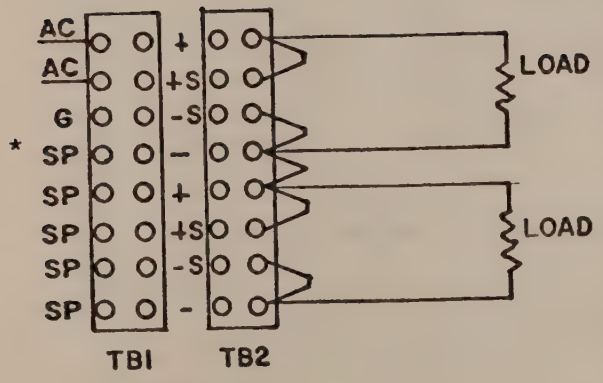


FIG. 5
LOCAL SENSING
SEPARATE LOADS

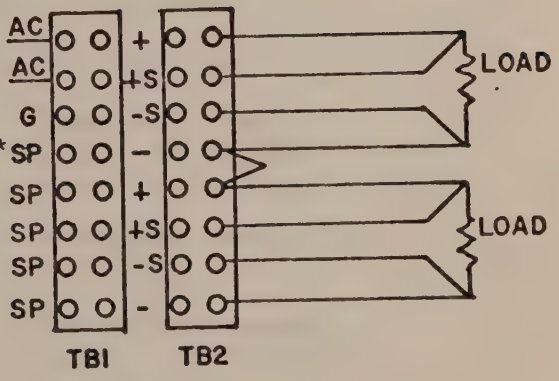


FIG. 6
REMOTE SENSING
SEPARATE LOADS

SECTION III

3-1 REPAIR, TROUBLESHOOTING, AND MAINTENANCE

An understanding of the operation of power supplies in general, and this series in particular, plus suitable test equipment and replacement parts, is a requirement for proper troubleshooting of a defective supply.

TROUBLESHOOTING CHART

SYMPTON	POSSIBLE CAUSE	SOLUTION
No Output	AC Input	Check TB1 pin 1 & 2 for AC input power.
	Blown Fuse	Replace
	Wiring	Check positive and negative sense leads for proper termination and polarity.
Output Voltage:		
Too High	Wiring	Check positive and negative sense leads for proper termination.
	Voltage Adjustment	Pot Adjustment
Too Low	Voltage Adjustment	Pot Adjustment
	Current Limit	Check for excessive load. See setup procedure.
No Adjustment	Wiring	Sense lead termination incorrect
	Current Limit	Check for excessive load. See setup procedure.

ELECTRICAL SPECIFICATIONS

AC INPUT: 3 positions on input/output strip AC, AC return and chassis ground. Input range 105-125V 47 to 440 HZ.

VOLTAGE REGULATION: Line, 105 to 125V AC, 0.1% +1MV, load, 0 to full rated, o.1% +1MV.

RIPPLE AND NOISE: 5.00 MV RMS, 15.0MV peak to peak.

TEMPERATURE RATINGS: Operating: $0^{o}C$ to $71^{o}C$
Storage: $-55^{o}C$ to $+85^{o}C$

STABILITY: .1% total drift for 24 hours following a 30-minute warmup under contant ambient conditions.

REMOTE SENSING: Since load current usually flows from positive to negative output terminals in dual supply applications these outputs are provided with separate sensing terminals to alleviate the unavoidable voltage drops always present on the load lines.

OVERSHOOT: None present, turn-on or turn-off.

OVERLOAD PROTECTION: Foldback current limiting set for approximately 125% of rated output. Continuous short circuits will not damage the power supply.

OVER VOLTAGE PROTECTION (OPTIONAL): A fixed differential over voltage protector is available which crowbars the output voltage if the output voltage exceeds a preset level. This level is 33V ±1.5V.

TRANSIENT RECOVERY TIME: For 50% load, changes recovery is to within .1% of regulated voltage in 50 microseconds.

OPTIONS: Change in normal input voltage to 210-250VAC 50HZ.

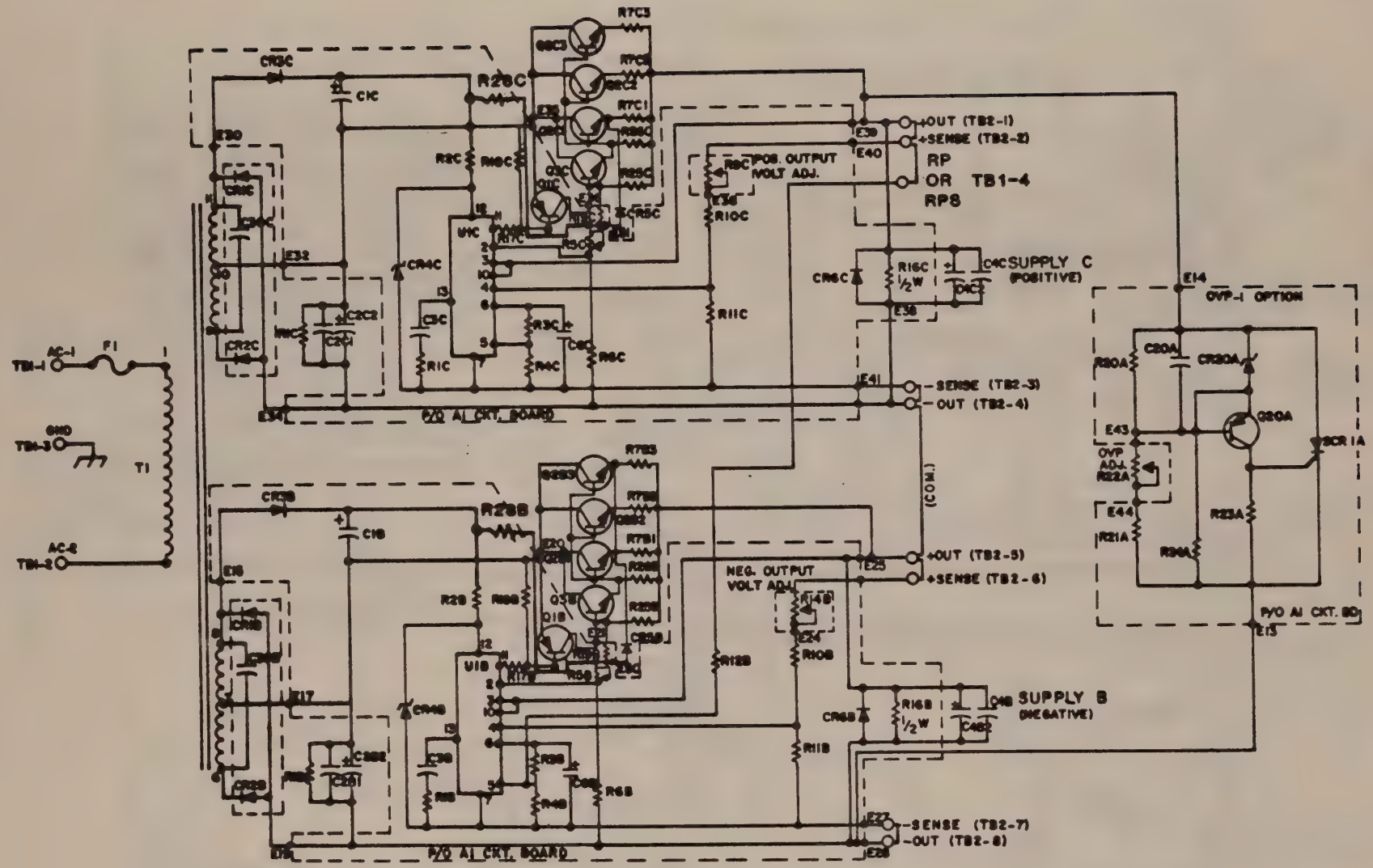
Mil type conformal coating over PC boards.

MECHANICAL: Finish-Modular-Gold Irridite Chassis. Black Identification.

OUTPUT CURRENT RATINGS

TABLE 1

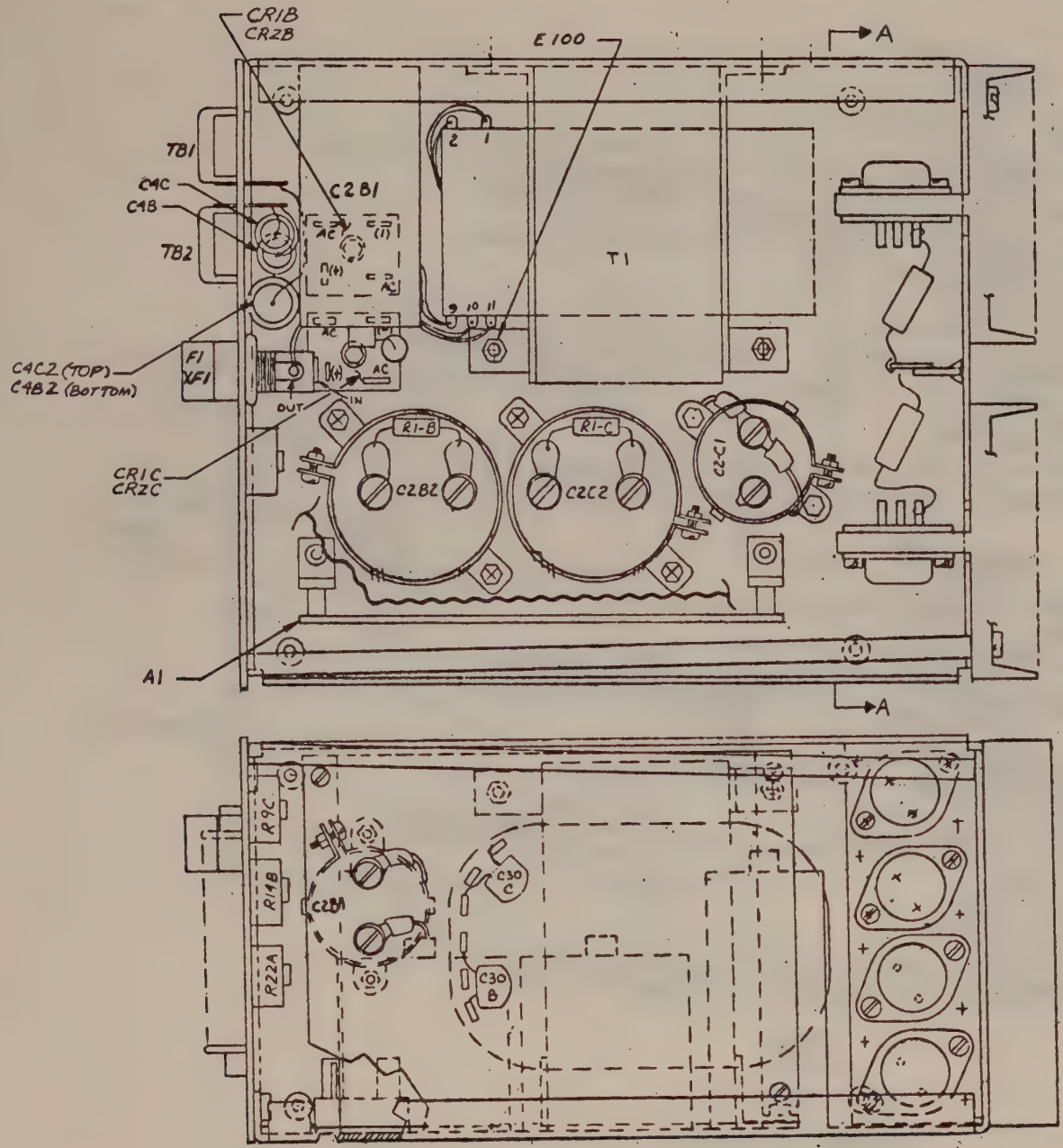
Voltage (Range)	CURRENT 40°C	50°C	60°C	71°C	Model No.
±12.0	7.20	6.10	5.04	3.96	RJD 212
±15.0	9.00	7.65	6.30	4.95	RJD 212
±12.0	9.20	7.80	6.44	5.06	RJE212
±15.0	11.50	9.75	8.03	6.32	RJE212

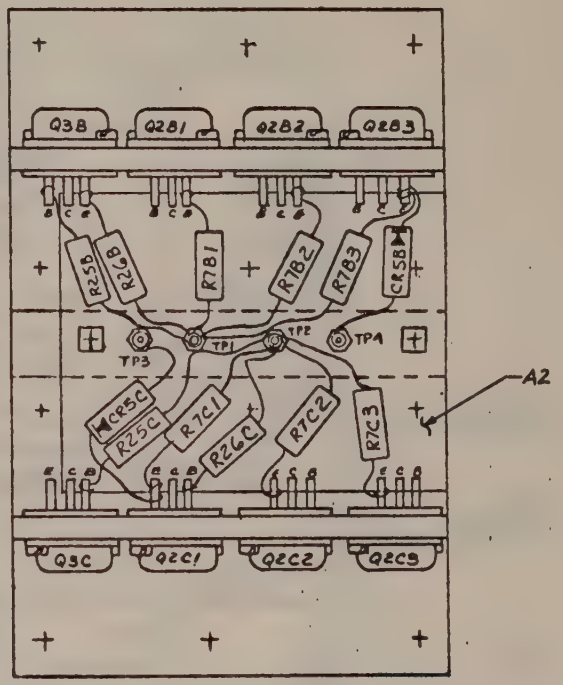


RJE212
RJD 212

FIGURE 7

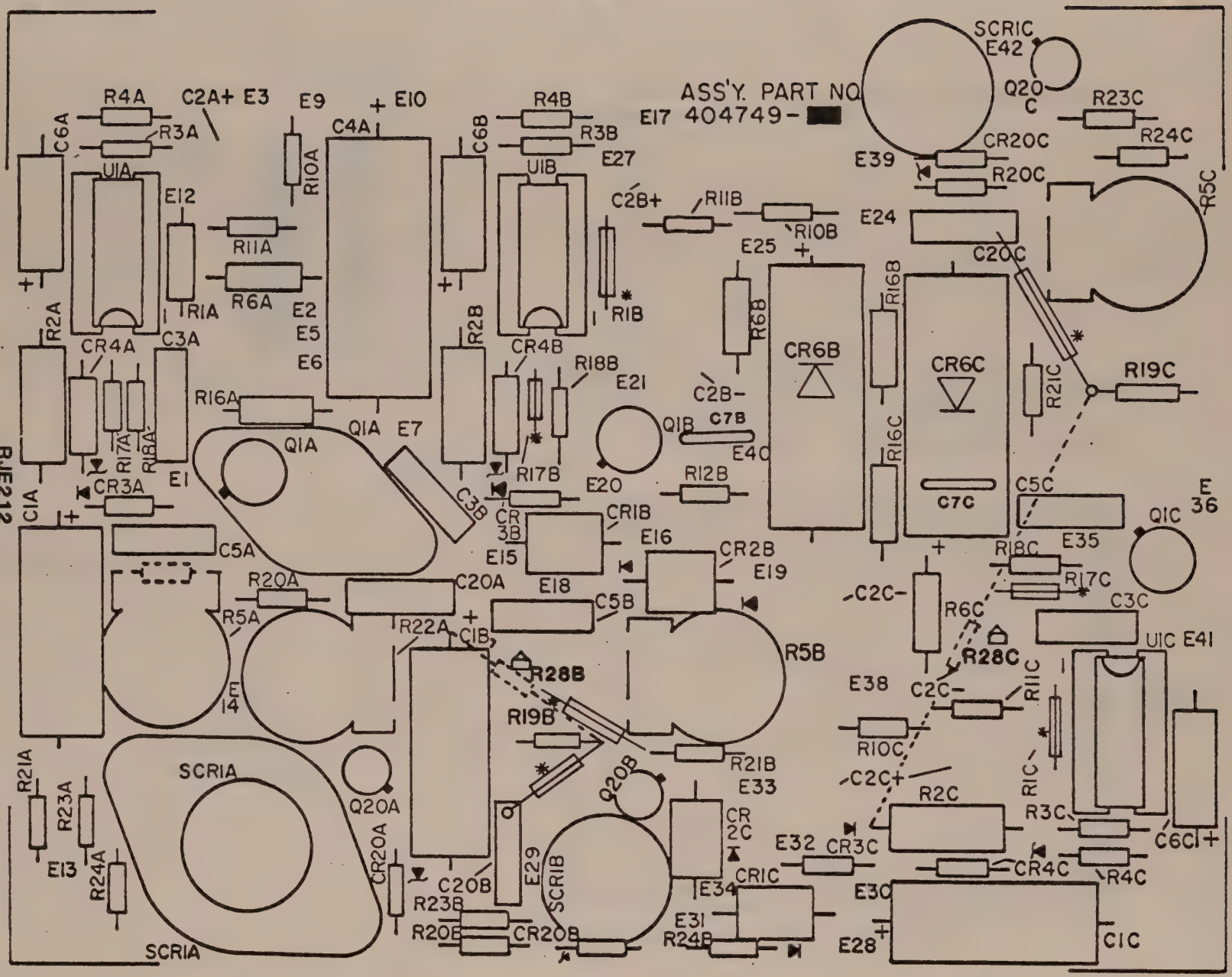
SCHEMATIC DIAGRAM





VIEW A-A

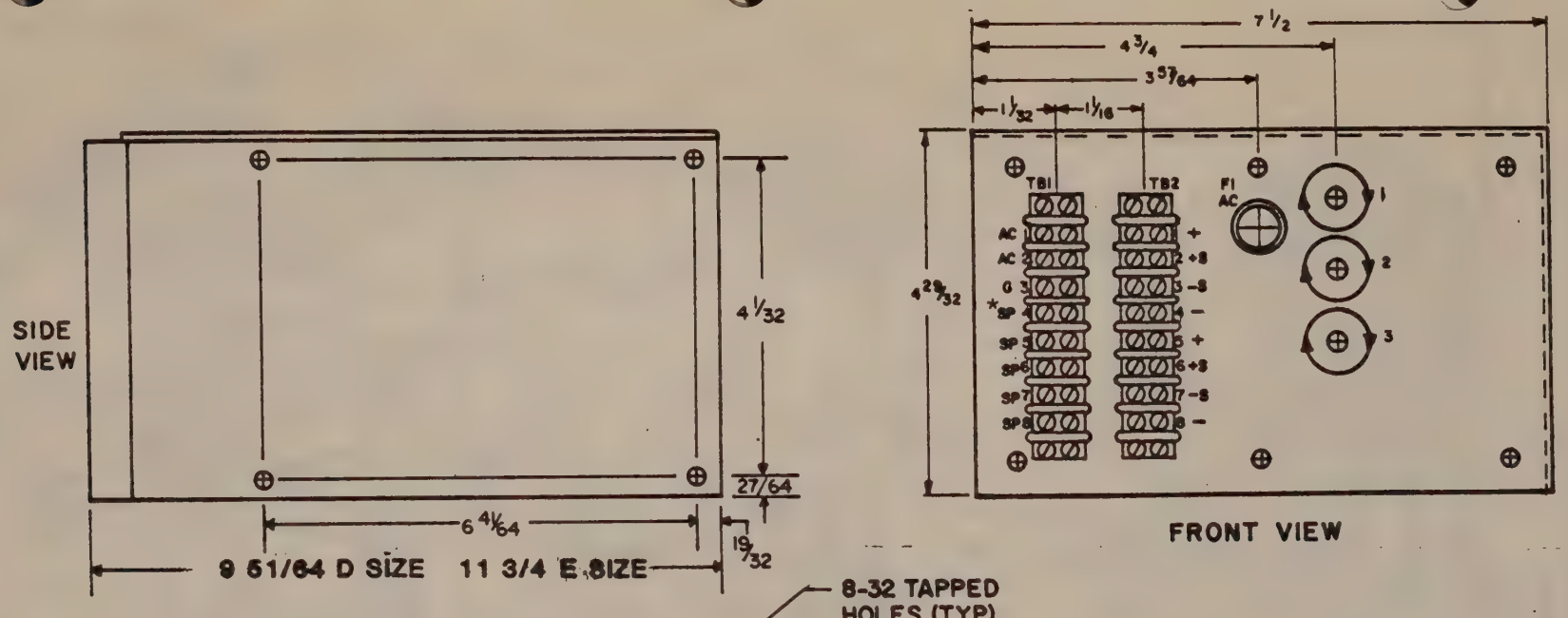
RJE212
RJD 212
FIGURE 8
PARTS PLACEMENT DIAGRAM



△ITEM IS FARSIDE

*ITEM IS JUMPER AND SLEEVE

RJE212
RJD 212
FIGURE 9
AI CIRCUIT CARD PARTS PLACEMENT



* MARKING MAY BE RP, RPS OR SP

RJE212
RJD 212
FIGURE 10
OUTLINE DRAWING

POWER SUPPLY
INSTRUCTION MANUAL

MODEL RS2E28-5S

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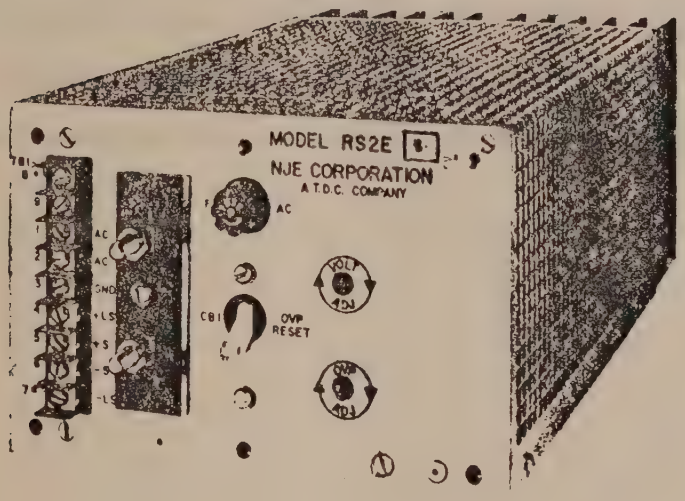
MODELS RJ, RS2, RX2

D, E, EE SERIES

POWER SUPPLIES



instruction manual

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SERIES START OPTION

GENERAL DESCRIPTION. The Series Start Option consists of a small printed circuit card containing the circuitry which holds off the power supply module's current limiter until the supply is up to rated voltage. Also included is a reverse polarity protection diode which is installed across the module's output terminals. If additional information is required, consult factory.

NJE CORP. DAYTON, N.J.	SIZE A	DATE 9/9/87	DWG. NO. 117831-010
	SCALE	REV.	SHEET 1 OF 1

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APPENDIX

Parts List (Spare)(Optional) . . . . . Rear of Manual

SECTION I

INTRODUCTION

1-1. SCOPE.

This manual is intended for use as a complete guidebook and reference document pertaining to the installation, testing, maintenance, and repair of the NJE D, E, & EE series modular power supply. Complete parts placement drawings, schematic diagram, test voltage, installation diagrams, and troubleshooting chart are included for the installation and maintenance of the D, E, & EE series power supply.

1-2. FUNCTION.

The RS, RS2, and RX2 series D, E, & EE power supply is a self-contained solid state unit operating from the AC line and supplying well-regulated DC voltage and current to electronic equipment. This power supply series is intended for low to medium current applications.

1-3. PERFORMANCE.

The NJE RJ, RS2, and RX2 line of power supplies are all silicon solid state circuits and include the utilization of integrated circuits. Additionally, all supplies are series regulated and are manufactured with high quality industrial grade components. The quality of the power supply is consistent with that required for the most sophisticated computer grade electronic systems in use today. The circuits used are extremely reliable and feature a high degree of simplification. The circuit simplification results in standardization of material and also gives greater reliability due to the reduction of components used in the basic circuits. The overall design philosophy utilized in this product line is based on standardization, simplicity, reliability, and high quality. For the output current ratings and voltages of standard models available in the D, E, & EE series, refer to Table 1A, 1B, and 1C respectively.

1-4. COMPARATIVE SPECIFICATIONS.

Table 2 lists in chart form the specifications of the RJ, RS2, and RX2 models of the D, E, & EE series power supply.

1-5. FEATURES.

1-5-1. OVER VOLTAGE PROTECTION (OVP) (Optional). SCR crowbar to limit maximum output voltage. Normally factory set at 1.5V or 20% (whichever is greater) above the nominal output voltage. OVP may be readjusted by customer via accessible adjustment. (See Maintenance Instructions)

1-5-2. CURRENT LIMITING. Current limiting may be set to limit maximum current from 75% to 125% of rated current. This current limiting adjustment is located internally and can be readjusted by customer. (See Maintenance Instructions)

TABLE 1A

VOLTAGE AND CURRENT RATINGS, D SERIES POWER SUPPLY

MODEL	VOLTAGE RANGE	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE			
		40°C	50°C	60°C	71°C
RJD 2	2± 0.1V	32.5	28.0	23.0	18.0
RS2D5/OVP	5± 0.5V	27.5	23.0	19.0	15.0
RX2D5/OVP	5± 0.25V	32.5	28.0	23.0	18.0
RJD5/OVP	5± 0.25V	32.5	28.0	23.0	18.0
RS2D 10	10± 1.0V	20.0	17.0	14.0	11.0
RS2D 12	12± 1.0V	18.0	15.3	13.0	9.9
RX2D 12	12± 0.6V	21.0	17.8	14.7	11.5
RJD 12	12± 0.6V	21.0	17.8	14.7	11.5
RS2D 15	15± 1.0V	15.0	13.0	10.5	8.2
RX2D 15	15± 0.75V	18.0	15.3	13.0	9.9
RJD 15	15± 0.75V	18.0	15.3	13.0	9.9
RS2D 18	18± 1.0V	13.0	11.1	9.1	7.2
RS2D 24	24± 1.0V	10.5	9.0	7.3	5.7
RX2D 24	24± 1.0V	12.5	11.0	8.7	6.8
RJD 24	24± 1.0V	12.5	11.0	8.7	6.8
RS2D 28	28± 1.0V	9.5	8.0	6.6	5.2
RX2D 28	28± 1.0V	11.0	9.0	7.7	6.0
RJD 28	28± 1.0V	11.0	9.0	7.7	6.0
RS2D 48	48± 2.0V	5.0	4.3	3.5	2.8
RX2D 48	48± 2.0V	6.5	5.5	4.6	3.6

Notes:
1. Current range must be chosen to suit the appropriate maximum ambient temperature.
2. Current ratings apply for entire voltage range.
3. D.C. output voltage regulated for line and load.

TABLE 1B

VOLTAGE AND CURRENT RATINGS, E SERIES POWER SUPPLY

MODEL	VOLTAGE RANGE	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE			
		40°C	50°C	60°C	71°C
RJE 2	2± 0.1V	41.0	34.0	29.0	22.0
RS2E 5/OVP	5± 0.5V	35.0	30.0	24.0	20.0
RX2E 5/OVP	5± 0.25V	41.5	34.0	29.0	22.0
RJE 5/OVP	5± 0.25V	41.5	34.0	29.0	22.0
RS2E 10	10± 1.0V	24.5	20.8	17.2	13.5
RS2E 12	12± 1.0V	22.5	19.1	15.7	12.3
RX2E 12	12± 0.6V	27.0	23.0	19.0	15.0
RJE 12	12± 0.6V	27.0	23.0	19.0	15.0
RS2E 15	15± 1.0V	19.0	16.0	13.3	10.4
RX2E 15	15± 0.75V	23.0	20.0	16.0	13.0
RJE 15	15± 0.75V	23.0	20.0	16.0	13.0
RS2E 18	18± 1.0V	15.0	12.8	10.5	8.3
RS2E 24	24± 1.0V	13.5	11.5	9.4	7.4
RX2E 24	24± 1.0V	15.5	13.0	11.0	8.5
RJE 24	24± 1.0V	15.5	13.0	11.0	8.5
RS2E 28	28± 1.0V	12.0	10.0	8.4	6.6
RX2E 28	28± 1.0V	14.0	12.0	9.8	7.7
RJE 28	28± 1.0V	14.0	12.0	9.8	7.7

NOTES:
1. Current range must be chosen to suit the appropriate maximum ambient temperature.
2. Current ratings apply for entire voltage range.
3. DC output voltage regulated for line and load.

TABLE 1C

VOLTAGE AND CURRENT RATINGS, EE SERIES POWER SUPPLY

MODEL	VOLTAGE RANGE	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE			
		40°C	50°C	60°C	71°C
RJEE 2	2V± 0.1V	44.5	37.8	31.1	24.4
RS2EE 5/OVP	5V± 0.5V	44.5	37.8	31.1	24.4
RX2EE 5/OVP	5V± 0.25V	52.5	44.6	36.7	28.8
RJEE 5/OVP	5V± 0.25V	60.0	51.0	42.0	33.0
RS2EE 12	12V± 1.0V	29.0	24.6	20.3	15.9
RX2EE 12	12V± 0.6V	34.0	28.9	23.8	18.7
RJEE 12	12V± 0.6V	34.0	28.9	23.8	18.7
RS2EE 15	15V± 1.0V	24.5	20.8	17.1	13.4
RX2EE 15	15V± 0.75V	29.0	24.6	20.3	15.9
RJEE 15	15V± 0.75V	29.0	24.6	20.3	15.9
RS2EE 24	24V± 1.0V	17.0	14.5	11.9	9.3
RX2EE 24	24V± 1.0V	20.0	17.0	14.0	11.0
RJEE 24	24V± 1.0V	20.0	17.0	14.0	11.0
RS2EE 28	28V± 1.0V	15.0	12.7	10.5	8.2
RX2EE 28	28V± 1.0V	18.0	15.3	12.6	9.9
RJEE 28	28V± 1.0V	18.0	15.3	12.6	9.9
RS2EE 36	36V± 1.5V	12.0	10.2	8.4	6.6
RX2EE 36	36V± 1.5V	14.0	11.9	9.8	7.7

NOTES:
1. Current range must be chosen to suit the appropriate maximum ambient temperature.
2. Current ratings apply for entire voltage range.
3. D.C. output voltage regulated for line and load.

1-5-3. REMOTE PROGRAMMING. 1 volt per volt or 500 ohms per volt (output terminal strip). See Section II for detailed connection information to operate supply in remote programming mode.

1-5-4. REMOTE SENSING. Sensing terminals separate from the load terminals provide regulation of the voltage at the load rather than regulation of the voltage at the power supply output terminals. This eliminates loss of load regulation due to the voltage drop in the wires connecting the supply to the load.

1-5-5. FAULT PROTECTION. All power supplies are protected with primary fuses and/or circuit breakers.

1-5-6. MISCELLANEOUS FEATURES. The following features are optionally available on these series power supplies: terminal board cover for input connection protection; line cord (3-wire, U-ground); special RMS input voltages with nominal values of 208, 220, 230, and 240 - range is ±10%.

1-6. ENVIRONMENTAL REQUIREMENTS.

The D, E, & EE series power supply is designed to be operated in a free-air (convection) mode. Special cooling and/or forced air (blower or fan) is not required for normal room temperature installations. Room temperature is considered to be nominal at 25° centigrade. However, should the power supply be operated in an ambient environment greater than 40° centigrade, the current output of the supplies must be derated at the rate of (1.5%/°C) up to a maximum ambient operating temperature of 71° centigrade. These series power supplies are commercial-grade equipments intended for fixed ground installation and should not be subjected to extreme adverse conditions of shock, vibration, or salt spray, etc.

1-7. ITEMS FURNISHED.

The D, E, & EE series power supply is furnished complete and pretested and is ready to install using the 8-32 mounting holes provided. Consult the Preparation for Use and Installation section of this manual for installation instructions.

1-8. ITEMS REQUIRED.

Required to put the D, E, & EE series power supply in operation is a suitable 3-wire, U-ground receptacle supplying 115VAC, 60 hertz nominal (except in the case of supplies operated from 187 to 264 VAC line). Wattage requirements are given in Table 2. A line cord will be necessary between power supply and receptacle, unless the line cord option is equipped. Interconnecting wiring from the power supply and equipment being powered is required as determined by the end usage of the power supply. Stranded wire insulated with PVC or teflon covering is recommended for interconnecting wiring and it is recommended that shielded cable be used for sense leads between supply and load if remote sensing is desired. (See Section II for explanation of remote sensing.) Refer to Figure 1 for determination of proper wire size required for the load connections. Additionally, 8-32 x 3/8 long mounting screws are required to fasten the power supply in place.

TABLE 2

TABLE OF SPECIFICATIONS, D, E, & EE SERIES POWER SUPPLY

SPECIFICATION	RS2	RX2	RJ
INPUT REQUIREMENTS	105-132V RMS @ 47-440 HZ.	*105-125V RMS @ 57-63 HZ.	105-125V RMS @ 47-440 HZ.
REGULATION MIN-MAX LINE NO LOAD TO FULL LOAD	 0.01% + 1 mV 0.01% + 1 mV	 0.1% + 1 mV 0.1% + 1 mV	 0.1% + 1 mV 0.1% + 1 mV
RIPPLE AND NOISE	1.0 mV RMS; 3 mV P-P		
TEMPERATURE RANGE OPERATING STORAGE	 -20°C to +71°C -55°C to +85°C	 0°C to +71°C -55°C to +85°C	 0°C to +71°C -55°C to +85°C
STABILITY (LONG TERM DRIFT)	0.1% (24Hr. PERIOD, AFTER 1/2Hr. WARM-UP)		
TRANSIENT RECOVERY TIME	50 MICROSECONDS TO 0.1%		
OVERSHOOT (OUTPUT)	NONE ON TURN-ON OR TURN-OFF		
OVERCURRENT PROTECTION	CURRENT FOLDBACK ADJUSTABLE 75-125% OF OUTPUT RATING		
REMOTE PROGRAMMING RESISTANCE VOLTAGE	 500 OHMS PER VOLT (OR) 1 VOLT PER VOLT		
REMOTE SENSING	PROVIDED		
INPUT PROTECTION	FUSE IN HOLDER AND CIRCUIT BREAKER ON FRONT PANEL		
CONNECTIONS	CINCH 140 TERMINAL BLOCK ON FRONT FOR ALL CONNECTIONS. 1/4-20 OUTPUT STUDS ON FRONT FOR POWER CONNECTIONS		
CONTROLS VOLTAGE ADJUST OVP ADJUST	 SCREWDRIVER ACCESS HOLE LOCATED ON FRONT PANEL SCREWDRIVER ACCESS HOLE LOCATED ON FRONT PANEL		
FINISH	GOLD IRRIDITE ALUMINUM CHASSIS AND HEAT SINKS		
MOUNTING	8-32 TAPPED MOUNTING HOLES PROVIDED ON THREE SURFACES FOR D & E, TWO SURFACES FOR EE		
COOLING	NORMAL CONVECTION COOLING, NO EXTERNAL HEAT SINKS REQUIRED		
SIZE	D	E	EE
	4-29/32" x 7-1/2" x 9-51/64"	4-29/32" x 7-1/2" x 11-3/4"	4-29/32" x 7-1/2" x 16-1/2"
WEIGHT	21 POUNDS	24 POUNDS	31 POUNDS
INPUT POWER REQUIREMENTS	460 VOLT-AMPS	600 VOLT-AMPS	850 VOLT-AMPS

* Units may be operated at 47-53 HZ. by derating to the next highest temperature range. See Table 1A, 1B, or 1C.

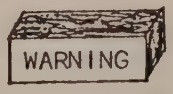
1-9. WARRANTY INFORMATION.

All NJE products listed in this manual are warranted against defects in material and workmanship for FIVE YEARS from date of shipment. This warranty is limited to the cost of parts and labor to restore units to the original factory condition. All shipping costs associated with the units to be repaired and any return shipment damages are the responsibility of the customer. NJE will not be responsible for any failure where the power supply has been used in an application for which it has not been designed or intended. If this power supply is sold to a manufacturer who is using it in a system, as an OEM buyer, which he is reselling, the guarantee above is transferable to the end user.

NOTE: Power supply(s) should not be returned to the factory for inwarranty repair unless the unit remains inoperable after referring to the troubleshooting section of this manual, and carrying out the instructions therein. For repair service or advice concerning an application problem, please contact the factory.

1-10. SAFETY PRECAUTIONS.

HAZARDOUS VOLTAGES. The D, E, & EE series power supplies are powered by 115 volt AC* line voltage which is a hazardous voltage to maintenance personnel. It is recommended the power supply be installed mechanically and the DC output connections be installed prior to plugging in the AC line cords. No hazardous voltages are present to the operator of the equipment during normal usage.



Observe proper safety procedures for 115 volt AC* levels when troubleshooting or servicing these series power supplies.
* (Optional inputs are higher)

Service and troubleshooting should only be performed by a qualified technician.

SECTION II

PREPARATION FOR USE AND INSTALLATION

2-1. PREPARATION FOR USE.

The power supply is shipped in a cardboard carton. Aside from normal precaution against damage to the unit in opening the cartons and removing the unit, no special procedures are required. The carton should be opened immediately upon receipt and the contents inspected for shipping damage. The power supply was checked electrically and mechanically before it left the factory, and is warranged to be in perfect operating condition. This guarantee does not cover possible damage incurred during shipment. Therefore, any evidence of mishandling, such as broken, deformed, or missing parts, should be brought to the attention of the transportation company and a claim should be entered. The literature packed with the supply should be removed and held for reference in operating the equipment. Refer to Figure 10 for an outline drawing of the D, E, & EE series power supply showing assemblies and controls.

2-2. INSTALLATION.

Do not attempt to operate the power supply if obvious mechanical damage has occurred. If the power supply has not sustained any shipping damage it may be installed.

NOTE

Make all connections to the system before applying power.

2-2-1. MECHANICAL INSTALLATION. Mount the power supply mechanically in its cabinet; usually with the equipment to be powered. Standard procedure is to mount the power supply(s) at the bottom of the rack cabinet, but this is not mandatory provided the ventilation requirements of paragraph 1-6 are met. Support the power supply while fastening it in place using four (4) or six (6) screws which must be provided. The power supply mounts by any of 2 or 3 surfaces as shown in Figure 10. Mounting screws should be 8-32 thread, no longer than 3/8" and snugged down tightly (minimum of 10 in-lbs. torque).

2-2-2. DC CONNECTIONS. A pair of 1/4-20 threaded output studs are provided at the front of the D, E, & EE series power supply. Lugs should be attached to the power connection wires prior to fastening to the output studs. Determination of correct wire size for power connections may be made by consulting Figure 1.

NOTE

Do not operate the power supply <u>with</u> the positive and negative sensing leads disconnected either remotely or locally.

2-2-3. LOCAL SENSING. The power supply is shipped in the local sensing mode. The local sensing mode is illustrated in Figure 2. In this mode, the power supply regulates the voltage at the output terminals and does not account for voltage drop between the output terminals and load. Should optimum regulation at the load be desired, the power supply may be connected in the remote sensing mode.. This and other useful operating modes are described in Section 2-2-4 through 2-2-8.

2-2-4. REMOTE SENSING. In the remote sensing mode, the supply voltage is regulated directly at the load terminals. As a result, regulation is not affected by the voltage drops in the leads connecting the power supply to the load. The remote sensing mode is illustrated in Figure 3. It is recommended that the sensing wires between TB1-5 and 6 to the load be a shielded twisted pair of 20 gauge AWG size.

2-2-5. REMOTE RESISTANCE PROGRAMMING WITH LOCAL SENSING. The remote resistance programming with local sensing mode allows the user to vary the output voltage of the supply without proximity to the power supply. The load regulation is subject to load connection cable voltage drop. The remote resistance programming with local sensing mode is illustrated in Figure 4. It is recommended that the wires between the power supply TB1-6 and 7 to the remote resistance be a 20 gauge AWG shielded twisted pair.

2-2-6. REMOTE RESISTANCE PROGRAMMING WITH REMOTE SENSING. Remote resistance programming with remote sensing allows the user to vary the output voltage of the supply without direct proximity to the supply while maintaining consistent load regulation unaffected by load connection cable voltage drop. This mode of operation is illustrated in Figure 5. It is recommended that the wires from the power supply to the remote resistance and from the remote resistance to the load be a 20 gauge AWG shielded twisted pair.

2-2-7. REMOTE VOLTAGE PROGRAMMING WITH LOCAL SENSING. Remote voltage programming with local sensing allows the user to vary the output voltage of the supply without proximity to the supply. The aforementioned is accomplished by utilizing a programming voltage. The load regulation is subject to load connection cable drops. This mode of operation is illustrated in Figure 6. It is recommended that a 20 gauge AWG shielded twisted pair be used to connect the power supply TB1-6 and 7 to the remote programming voltage.

2-2-8. REMOTE VOLTAGE PROGRAMMING WITH REMOTE SENSING. Remote voltage programming with remote sensing allows the user to vary the output voltage of the supply without proximity to the supply while maintaining consistent load regulation. The output voltage of the power supply if varied utilizing a remote voltage source. The load regulation is not subject to load connection cable voltage drop in this mode of operation, which is illustrated in Figure 7. It is recommended that the wiring from power supply to remote voltage source and from source to load be a 20 gauge AWG shielded twisted pair.

2-2-9. AC CONNECTIONS. Install a line cord with minimum 16 gauge AWG wire with ground to the terminals marked AC, AC, and GND on TB1 at the front of the supply, unless the supply is ordered with the line cord option. Plug this cord into a grounded, 115 VAC, 60 hertz receptacle. Special voltage input power supplies may be provided with a plug and receptacle at the user's discretion, such as a TWIST-LOK plug for 230 VAC. The power supply is now ready to be operated.

SECTION III

THEORY OF OPERATION

3-1. GENERAL THEORY OF OPERATION

The input AC is applied through the fuse and the circuit breaker switch* to the primary of the power transformer. AC from the load power secondary is rectified and capacitive filtered to provide the raw DC voltage for the series pass section. This voltage is also peak rectified and filtered in the boost circuit to provide a higher voltage level for the driver(s) on some units. A separate bias winding on the power transformer provides AC voltage which is rectified and filtered to power the control circuitry.

The control circuitry contains an error amplifier and a reference voltage within a 723 Integrated Circuit Regulator. The output voltage is compared to the reference voltage and the error amplifier corrects for any difference. The correction will always oppose any change in the output voltage caused by either input line or output load variation.

The output current is sensed in the pass section and if a pre-set limit is reached the current limiter stage will inhibit the amplifier output and reduce the load current as the load demand is increased (load resistance decreased). This sensing is of the fold back type which lowers the point of current limit as the output voltage falls.

The over voltage protection circuitry is connected directly across the output terminals and senses the output voltage. If this voltage exceeds a pre-set level, a silicon controlled rectifier (SCR) is triggered on which crowbars the output and opens the primary circuit breaker, protecting the load, the supply, and the power line. (For OVP Option)

3-2. DETAILED CIRCUIT DESCRIPTION.

The following descriptions list the components used in these series power supplies and the function of each component used. Refer to the schematic and parts placement drawing at the rear of this manual for specific component location (Figures 11, 12, and 13).

3-2-1. MAIN ASSEMBLY COMPONENTS.

COMPONENT	FUNCTION
* CB1	Interrupts AC power to the primary winding of T1 when OVP network is activated. (With OVP Option only)
F1	Fuse. Protects supply from excessive current conditions.
T1	Power transformer. Electrostatic shielded, vacuum impregnated with epoxy varnish.
C2A, C2B	Main filter capacitors. Reduces ripple voltage to pass section. (C2B not on all units)

COMPONENT	FUNCTION
R1	Bleeder resistor. Provides discharge current path for main filter capacitors.
TH1	Protects the power supply from failing during an overheated condition by opening the transformer primary circuit (Optional).

3-2-2. A1 CIRCUIT CARD COMPONENTS.

COMPONENT	FUNCTION
R1	Limits the current through CR5.
R2	Current limiting resistor for protection of IC1.
R3	Absorbs Icbo of Q2 to prevent thermal runaway.
R4	Variable portion of current limiting network, consisting of R4 and R5.
R5	Fixed portion of current limit network. Determines the minimum value of load current that the circuit will current limit.
R6	Absorbs Icbo of pass transistors Q1A-Q1D or Q1E or Q1F.
R9	Determines the fold back characteristics.
R10	The resistive portion of the RC network that provides current limit delay at turn-on.
R11	Limits current to the base of Q5.
R12	The fixed portion of the voltage divider in the OVP triggering network. (OVP Option)
R13	Limits gate current to SCR1. (OVP Option)
R14	Determines the minimum triggering voltage of the OVP network. (OVP Option)
R15	Variable portion of voltage divider that determines OVP trip level. (OVP Option)
R16	Prevents false triggering of SCR1. (OVP Option)
R17	Output bleeder resistor. Provides discharge current path for C7.
R18	The resistive portion of the RC network that provides frequency compensation for IC1.

COMPONENT	FUNCTION
R19	Forms a voltage divider with R20 to provide a reference voltage at pin 4 of IC1 with respect to pin 7 of IC1.
R20	See R19.
R21	Provides a constant current (approx. 2mA) for the programming resistors R22 and R23.
R22	The fixed portion of the programming resistors. Determines the minimum output voltage level.
R23	The variable portion of the programming resistor network that determines the output voltage level.
R24	Limits the maximum current and reduces the power dissipation of Q6.
R25	Absorbs Icbo of Q6.
R26	Limits the output voltage variation when the positive sense lead is removed. (Normally by-passed when positive sense lead is connected.)
R28	Provides stabilization in conjunction with C9.
R29	In conjunction with C6, improves transient response and reduces output ripple.
R30	Limits voltage to Q6 and limits power dissipation of Q6. (Not used on all models.)
R32	Current limit resistor. Limits surge through CB1 and SCR1 when power supply goes into OVP mode. (OVP Option)
R33	Provides path for bias current flow of CR4.
C1	Filter capacitor for bias supply. (Not used on all models.)
C3	The capacitive portion of the RC network that provides frequency compensation for IC1.
C4	Provides current limit delay at turn-on.
C5	Delays the response of the OVP circuit to prevent false triggering. (OVP Option)
C6	In conjunction with R29, improves transient response and reduces output ripple.
C7A-C7C	Output capacitors. Reduces output noise and provides closed loop stabilization. (C7B and C7C not used on all models.)
C8	Reduces noise at reference portion of IC1. Prevents voltage overshoot at turn-on.

COMPONENT	FUNCTION
R1	Bleeder resistor. Provides discharge current path for main filter capacitors.
TH1	Protects the power supply from failing during an overheated condition by opening the transformer primary circuit (Optional).

3-2-2. A1 CIRCUIT CARD COMPONENTS.

COMPONENT	FUNCTION
R1	Limits the current through CR5.
R2	Current limiting resistor for protection of IC1.
R3	Absorbs Icbo of Q2 to prevent thermal runaway.
R4	Variable portion of current limiting network, consisting of R4 and R5.
R5	Fixed portion of current limit network. Determines the minimum value of load current that the circuit will current limit.
R6	Absorbs Icbo of pass transistors Q1A-Q1D or Q1E or Q1F.
R9	Determines the fold back characteristics.
R10	The resistive portion of the RC network that provides current limit delay at turn-on.
R11	Limits current to the base of Q5.
R12	The fixed portion of the voltage divider in the OVP triggering network. (OVP Option)
R13	Limits gate current to SCR1. (OVP Option)
R14	Determines the minimum triggering voltage of the OVP network. (OVP Option)
R15	Variable portion of voltage divider that determines OVP trip level. (OVP Option)
R16	Prevents false triggering of SCR1. (OVP Option)
R17	Output bleeder resistor. Provides discharge current path for C7.
R18	The resistive portion of the RC network that provides frequency compensation for IC1.

COMPONENT	FUNCTION
R19	Forms a voltage divider with R20 to provide a reference voltage at pin 4 of IC1 with respect to pin 7 of IC1.
R20	See R19.
R21	Provides a constant current (approx. 2mA) for the programming resistors R22 and R23.
R22	The fixed portion of the programming resistors. Determines the minimum output voltage level.
R23	The variable portion of the programming resistor network that determines the output voltage level.
R24	Limits the maximum current and reduces the power dissipation of Q6.
R25	Absorbs Icbo of Q6.
R26	Limits the output voltage variation when the positive sense lead is removed. (Normally by-passed when positive sense lead is connected.)
R28	Provides stabilization in conjunction with C9.
R29	In conjunction with C6, improves transient response and reduces output ripple.
R30	Limits voltage to Q6 and limits power dissipation of Q6. (Not used on all models.)
R32	Current limit resistor. Limits surge through CB1 and SCR1 when power supply goes into OVP mode. (OVP Option)
R33	Provides path for bias current flow of CR4.
C1	Filter capacitor for bias supply. (Not used on all models.)
C3	The capacitive portion of the RC network that provides frequency compensation for IC1.
C4	Provides current limit delay at turn-on.
C5	Delays the response of the OVP circuit to prevent false triggering. (OVP Option)
C6	In conjunction with R29, improves transient response and reduces output ripple.
C7A-C7C	Output capacitors. Reduces output noise and provides closed loop stabilization. (C7B and C7C not used on all models.)
C8	Reduces noise at reference portion of IC1. Prevents voltage overshoot at turn-on.

COMPONENT	FUNCTION
C9	Provides stabilization in conjunction with R28. (Not used on all models.)
C10	Filter capacitor for bias supply. (Not used on all models.)
C11	Provides stability during remote sense operation. (Not used on all models.)
C12	Provides stabilization of the current limit circuit.
C13	Prevents turn-on overshoot.
CR1	Rectifier. Provides DC voltage for bias circuit. (Not used on all models.)
CR2	Rectifier. Same as CR1.
CR3	Provides temperature compensation for the current limit transistor, Q5.
CR4	Zener diode. Provides reference voltage for OVP network. (OVP Option)
CR5	12 volt zener diode. Provides regulated voltage for IC1.
CR6	Isolates unregulated voltage from the output. Conducts current through SCR1 to short circuit the output during OVP operation. (OVP Option)
CR7	Bridge rectifier. Provides DC voltage to bias circuit. (Not used on all models.)
Q3	Provides drive from IC1 to Q6.
Q4	OVP transistor. Provides a gate signal to SCR1 during OVP conditions. (OVP Option)
Q5	Current limit transistor. During current limit Q5 conducts, thus decreasing the available output voltage of IC1.
Q6	Current amplifier. Provides base drive to Q2 of A2 Assembly.
SCR1	Silicon Controlled Rectifier. Crowbars circuits output during OVP mode. (OVP Option)
IC1	723 voltage regulator integrated circuit. Provides reference and control circuitry for regulator loop.

3-2-3. A2 HEAT SINK ASSEMBLY.

COMPONENT	FUNCTION
R7A-R7G	Emitter resistors. Provides current sharing of Q1A-Q1G. Also used for current limit sense resistors. (E, F, & G some models only)

COMPONENT	FUNCTION
Q1A-Q1G	Pass transistors. Connected in parallel for current sharing. (E, F, & G some models only)
Q2	Driver transistor. Provides current amplification for pass stage.

3-2-4. A3 HEAT SINK ASSEMBLY.

COMPONENT	FUNCTION
CR1-CR2	Power rectifiers. Provides full wave rectified DC voltage to pass section.
C1	Suppresses commutation spikes.

3-2-5. uA 723 IC PIN DESIGNATION.

PIN NUMBER	FUNCTION
1.	No connection.
2.	Internal current limit - not used.
3.	Internal current limit - not used.
4.	Inverting input.
5.	Non-inverting input.
6.	Reference voltage - nominal 7.1 VDC.
7.	Common.
8.	No connection.
9.	Not used.
10.	Output.
11.	Input voltage to output stage of IC.
12.	Input voltage to low level stages of IC.
13.	Frequency compensation and external current limit control of IC.
14.	No connection.

SECTION IV

OPERATING INSTRUCTIONS

4-1. GENERAL OPERATING INSTRUCTIONS.

The RJ, RS2, and RX2 D, E, & EE series power supply has a minimum of controls and is not difficult to operate. All controls used in normal operation are placed on the front panel and input/output connections are also at the front. The supply may be turned on and off with the circuit breaker on the front panel. All control adjustment procedures are detailed in Section V, Maintenance Instructions.

4-2. CONTROL FUNCTIONS.

The front panel of the D, E, & EE series power supply contains an input terminal board, output terminals, a circuit breaker switch (with OVP only), fuse holder, and voltage adjust control. Also on units equipped with OVP there is an OVP set point adjust control. The function of each of these components follows:

1. CIRCUIT BREAKER. Interrupts AC power to the primary winding of the transformer when OVP network is activiated. Also used as an on/off switch for the power supply. Protects the power supply (and gives visual indication) during over voltage protection.

2. FUSE HOLDER. Contains primary circuit fuse which protects power transformer (and supply) from catastrophic failure.

3. OVP ADJUST POT. Screwdriver adjustment provided on units with OVP option to set over voltage protection set point.

4. VOLTAGE ADJUST POT. Screwdriver adjustment provided to set output voltage within its normal range. See Table 1 for voltage adjust ranges available on standard units.

4-3. NORMAL OPERATION.

Consult Section II for preparation for use and installation instructions. After the power supply is installed, place the circuit breaker in the * upward or "on" position to operate the unit. No initial adjustments are required. (* OVP Option units only)

4-4. OVER VOLTAGE PROTECTION. (OPTIONAL)

If a voltmeter across the supply output registers between 1.0 and 1.5 volts DC, the supply may be in the OVP mode. The output protection crowbar circuit has tripped due to an over voltage condition at the output terminals caused either internally or externally to the power supply. The power supply may be reset to normal operation by turning the circuit breaker to the off position and turning back on (up position) after one or two seconds. Failure of the supply to attain rated output voltage after tryIng this procedure is a fault condition and the operator should refer to paragraph 5-2, Troubleshooting Instructions.

4-5. SHUTDOWN.

No special procedure is required for power supply shutdown. Flipping the circuit breaker down to the "OFF" position turns off the supply. For units without a circuit breaker (no OVP Option) removing power to the AC input on TB1-1 and 2 turns off the power supply.

SECTION V

MAINTENANCE INSTRUCTIONS

5-1. ROUTINE MAINTENANCE.

The only routine maintenance of the RJ, RS2, and RX2 D, E, & EE series power supply necessary is cleaning. For other than routing maintenance, refer to paragraph 5-2, Troubleshooting Instructions and paragraph 5-7, Disassembly, Repair, Replacement, Reassembly. The D, E, & EE series power supplies are designed for years of trouble-free service. The only physical maintenance required is once or twice per year (depending on how dirty the environment in which they are mounted) the power supply should be cleaned of dust which may accumulate. Since the power supply is convection cooled, a great accumulation of dust on the perforated dust cover and rear heat sink may in time hinder the free flow of cooling air. This dust accumulation may be removed with a brush or vacuum cleaner with a brush attachment.

5-2. TROUBLESHOOTING INSTRUCTIONS.

Table 3 lists possible equipment malfunctions which may occur to the D, E, & EE series power supply during normal operation. The Table gives symptom, possible cause, and remedy to restore equipment to normal operation. When trouble occurs, systematically check all fuses, primary power lines, and external circuit elements and wiring for malfunction before troubleshooting the power supply equipment. Malfunctions can often be traced to simple causes such as improper sensing, connections, or fuse failure due to fatique.

5-3. VOLTAGE ADJUST SETTING PROCEDURE.

The voltage adjust pot is a screwdriver adjust pot located on the front panel. To adjust, turn the pot with a standard flat screwdriver clockwise to increase voltage and counter-clockwise to decrease voltage. Observe output voltage reading on a test voltmeter and set pot to obtain desired output voltage.

5-4. CURRENT LIMIT SETTING ADJUSTMENT.

The correct setting of the current limit adjust pot (see shcematic and parts placement drawings for location of this control) is such that the supply will begin to fold back its output voltage when output current reaches 120% of rated 40°C current. See Table 1 for correct rated current value.

NOTE

Setting the current limit too close to the nominal current will give poor load regulation.

5-4-1. CURRENT LIMIT ADJUSTMENT PROCEDURE.

The adjustment procedure requires that the power supply module is disconnected from associated equipment, is at an ambient temperature of 25-30°C, and has not been operated with load for at least one hour. Whenever rated output of the supply module cannot be attained, adjust the current limit pot as follows: (see page 5-4)

TABLE 3

TROUBLESHOOTING (Sheet 1 of 2)

SYMPTOM	POSSIBLE CAUSE	REMEDY
No output voltage.	No AC input.	Line cord frayed or pinched - replace.
		AC receptacle inoperative - check line fuses or breaker.
	Blown fuse, F1.	Check fuse F1 on front panel.
	Faulty wiring.	Check output connections for tightness on TB1, E1, and E2.
		Check output cables to equipment being powered for shorts or open leads.
	Faulty rectifiers.	Check main rectifiers CR1 and CR2 for presence of voltage. Rectifiers may be shorted if no voltage present. Likewise check for voltage at emitter of pass transistors Q1A-Q1G. Replace open or shorted components.
	Faulty regulator IC1.	Replace regulator EC1 if above steps do not return output voltage to normal.
Output voltage low.	Power supply operating in current foldback mode.	Remove load, check load value and check for shorts and/or improper supply-load connections.
	Power supply in over voltage protection mode. (OVP Option)	Turn AC circuit breaker off, turn on after one or two seconds.
		If output does not come up, check OVP adjust setting. (See paragraph 5-5.)
		If OVP is set at max and output does not come up, check OVP circuit components: A1-CR4, A1-Q4, A1-SCR1, A1-CR6.
	Faulty current limit transistor A1-Q5	Check current limit transistor for short, replace.
	Voltage regulator IC1 loose.	Check IC1 for tightness in socket.

SYMPTOM	POSSIBLE CAUSE	REMEDY
Cannot adjust output voltage.	Damaged voltage adjust control pot R23.	Check voltage adjust pot R23 on front panel for short or open, replace as required.
	Module operating as constant current source at current limit value.	Remove load, check load value and check for shorts and/or improper supply-load connections.
Output voltage too high.	Improper output terminal connections.	Check output sensing connections from TB1.
	Shorted pass transistor(s) Q1A-Q1G.	Check pass transistor(s) Q1A-Q1E for short, replace if necessary.
Poor voltage regulation.	Loose load connections.	Check supply-load connections.
	Improper sensing connections.	Check supply-load voltage sensing connections. See Section 2-2.
	Voltage regulator IC1 loose.	Check that voltage regulator IC1 is tight in socket.
	Faulty voltage regulator IC1.	Replace IC1 if above steps do not help.
	Power supply in current limiting mode.	Check that the load current does not exceed rating per Table 1. Refer to Section 5-4-1 if any adjustment is required.
High ripple on output.	Improper ground connections.	Ground positive or negative output terminal at the module.
	Faulty filter capacitor(s) C2A and/or C2B.	Check rectifier diodes for short if ripple is over 2 volts, replace if shorted.
Power supply overheats.	Output current too high.	Check that output current does not exceed rated value (See Table 1). If over, check load requirement.
	Poor ventilation.	Check power supply dust cover and cooling holes (and fins where applicable) for blockage by dust or improper installation. (See Section 1-6.)

1. Determine current limit pot designation by referring to schematic in Figure 12. Locate this pot on the module A1 circuit.

2. Remove AC power from power supply system and gain access to current limit pot by removing module cover.

3. Connect power supply for constant voltage with local sensing as shown in Figure 9.

4. Turn voltage adjust control on front panel to minimum output voltage.

5. Apply a resistor load to output terminals so that output current is 120% of 40°C rating of unit. Refer to Table 1, Voltage and Current Ratings for correct rated output current.

6. Using an oscilloscope, Taktronix 503 or equivalent, observe output voltage of supply while adjusting current limit pot in a counter-clockwise direction. Adjust until output ripple increases sharply and oscilloscope pattern changes.

7. Recheck setting by increasing load from rated value to 120% of rated value and observing oscilloscope for sharp increase in output ripple at 120% point. Repeat procedure if necessary.

8. Reassemble top cover.

5-5. OVER VOLTAGE PROTECTION ADJUSTMENT.

The correct setting of the over voltage protection pot (located on the front panel of the supply) is 1.5V or 20% (whichever is greater) above nominal reated output voltage of the supply. Refer to Table 1 for correct output voltage of the unit.

5-5-1. OVP ADJUSTMENT PROCEDURE. (ON UNIT WITH OVP OPTION ONLY)

The adjustment procedure requires that the power supply be disconnected from associated equipment.

1. The OVP pot is on the front panel of these series power supplies.

2. Turn the OVP adjust pot fully clockwise. The correct OVP setting is 1.5V or 20% (whichever is greater) above nominal rated output voltage of the module being adjusted. Refer to Table 1.

3. Turn on the power supply and raise the output voltage to this desired over voltage protection point. Monitor output voltage by connecting an external voltmeter to the output of the supply and raise voltage by adjusting front panel volt adjust pot. Some units will require an external voltage source to set the OVP at the desired voltage.

4. Slowly turn the OVP pot counter-clockwise until the voltmeter suddenly drops to between 1 and 1.5 volts and CB1 (OVP reset) trips indicating that the over voltage protection point is reached.

5. The over voltage protection point is now set. Turn down voltage adjust pot before turning on power supply again.

6. Turn on supply and reset output voltage to correct nominal value. Refer to Section 5-3 for specific voltage adjust setting procedures.

5-6. PERFORMANCE VERIFICATION.

It may be necessary to check the performance of these series power supplies periodically. Specific parameters of performance are given for each of the power supply models in these series in Table 2, Table of Specifications. The power supply parameters may be verified with the test set up illustrated in Figure 9. This testing is to be performed by a trained electronic technician utilizing the following equipment (or equivalent).

1. A variable resistor load appropriately rated for the model being tested.

2. A DC ammeter, 0 to 50 amps, ±2% accuracy.

3. An AC ammeter, 0 to 10 amps, ±2% accuracy.

4. An RMS voltmeter, Ballantine model 320 or equivalent.

5. A digital voltmeter (DVM), Data Precision 902 or equivalent.

6. An AC variac, switched, with grounded 3-wire receptacle, capable of supplying 10 amps AC.

7. An AC voltmeter, 0 to 150 VAC, ±5% accuracy.

8. An oscilloscope, Tektronix model 503 or equivalent.

9. A 5-position terminal board to make connections to the power supply under test.

5-6-1. LINE REGULATION.

Turn on power supply and load to full rated current at 40°C, as listed in Table 1. Measure and record the output voltage of the supply using the DVM at 105 volts AC input. Turn up the variac to 132 volts AC input (for RS2D, E, & EE supplies) to the supply; measure and record output voltage. The difference between these output readings should not exceed 0.01% + 1mV of the maximum reading noted, or 0.1% + 1mV of the maximum reading noted for RX2D, E, & EE and RJD, E, & EE supplies, with a line swing from 105-125 VAC.

5-6-2. RIPPLE.

Measure the RMS ripple on the output of the supply using the RMS voltmeter with the supply at full load as determined in paragraph 5-6-1, and at nominal AC input voltage. Ripple on the DC output should not exceed 1.0 millivolts RMS.

5-6-2. NOISE.

Measure noise on the output of the power supply using the oscilloscope with the supply at full load as in paragraph 5-6-2. Noise should not exceed 3.0 millivolts peak-to-peak.

5-6-3. LOAD REGULATION.

With the supply at nominal input AC voltage, load to full rated current as determined by Table 1; measure and record the output voltage on the DVM. Remove the load and measure and record output voltage. The difference between these readings should not exceed 0.01% + 1mV of the maximum reading obtained for RS2D, E, & EE supplies; or 0.1% + 1mV of the maximum reading for RX2D, E, & EE and RJD, E, & EE supplies.

5-6-4. OVER VOLTAGE PROTECTION CHECK.

The over voltage protection circuit may be checked on the supply while in the test set-up of Figure 9. Refer to paragraphs 5-5 and 5-5-1 for OVP check and reset procedure.

5-6-5. CURRENT LIMITER CHECK.

The power supply current limiter circuit may be checked using the test set-up of Figure 9. With supply on and nominal AC input voltage applied, set the output voltage at minimum, load the supply to full load as in paragraph 5-6-1. Increase load current (decrease load resistance) slowly until the output voltage begins to drop. This is the current limit point. The current limit point or point where output voltage begins to drop should be approximately 120% of the rated output current at 40°C.

5-6-6. DEVIATIONS.

Any deviations from standard as noted in paragraphs 5-6-1 through 5-6-5 when performing any or all tests described may constitute a power supply failure. Refer to paragraph 5-2, Troubleshooting Instructions for possible causes and remedy of power supply failure.

5-7. DISASSEMBLY, REPAIR, REPLACEMENT, REASSEMBLY.

NOTE

Repair in excess of those indicated in Table 3, Troubleshooting, may jeopardize the warranty. Therefore, consult the factory with details for any extraordinary repair that may be required.

Repair of the D, E, & EE series power supply will be limited to replacing defective components found in performance of Maintenance and Troubleshooting techniques as described in paragraphs 5-1 and 5-2, respectively. For location of specific parts and assemblies, please refer to the Parts Placement Diagrams, Figures 11 and 12.

5-7-1. DISASSEMBLY. Disassemble parts in a logical fashion and save all hardware including locking washers so that it may be reassembled as it was taken apart. There are four (4) screws holding the power supply cover. There are five (5) screws holding the A1 circuit card in place which are removed from the front of the unit.

5-7-2. REPAIR, REPLACEMENT. Repair of the power supply and its components is limited to replacement of defective components with new ones and testing as described in paragraph 5-6, Performance Verification. When working with the printed circuit board contained within the power supply, the following techniques should be adhered to if it becomes necessary to change components.

1. Always use a heat sink when soldering transistors and diodes.

2. Broken or damaged printed wiring is usually the result of an imperfection, strain or careless soldering. To repair small breaks, tin a short piece of hook-up wire to bridge the break, and holding the wire in place, flow solder along the length of wire so that it becomes part of the circuitry.

3. When unsoldering components from the board never pry or force loose the part; unsolder the component by using the wicking process. Place the wick onto the soldered connection and apply soldering iron onto the wick, freeing the component, simultaneously remove iron and wick.

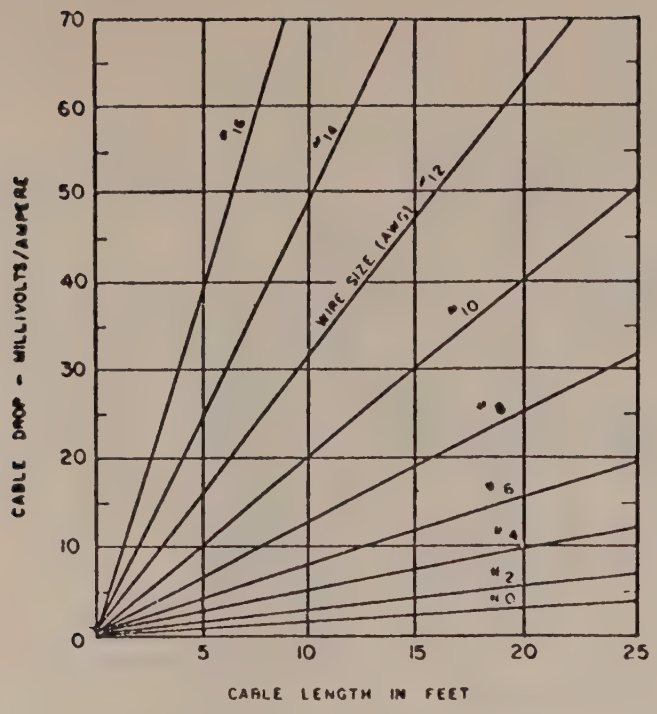
5-7-3. REASSEMBLY. Reassemble the power supply in reverse procedure to that used in disassembly. Be sure to fasten all screws with locking hardware and tighten snugly. Refer to Figures 11 and 12 for complete parts placement diagrams. Upon completion of reassembly refer to paragraph 5-6, Performance Verification, for checking out operation of the power supply.

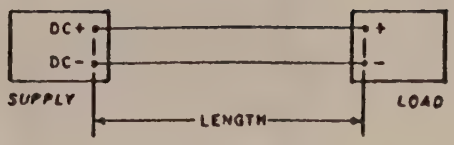
5-8. PACKING FOR RESHIPMENT.

When packaging a power supply for reshipment, roll up the power cord (if equipped) and tie it securely. To prevent scratching and keep out dampness the system may be tied in a plastic bag prior to sealing in a cardboard box. A dessicant may be added to the plastic bag to absorb moisture. The shipping container may be a corrugated, cardboard box tailored to fit the supply snugly or fitted with wadding or extra pieces of cardboard. The power supply should not be loose in its shipping container. Mark container adequately as to contents.

5-9. STORAGE INSTRUCTIONS.

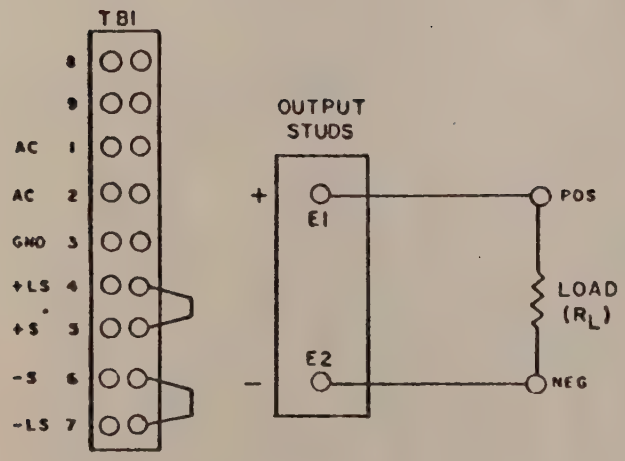
The power supply may be stored open or boxed as in paragraph 5-8. Storage temperature range permissable is -55°C to +85°C. If a power supply is to be stored for a long period of time, a waterproof or overseas shipping container should be used. Avoid storage of electronic equipment in damp areas. When reactivating stored systems after eighteen months or more, it is advisable to check performance as in paragraph 5-6, Performance Verification.





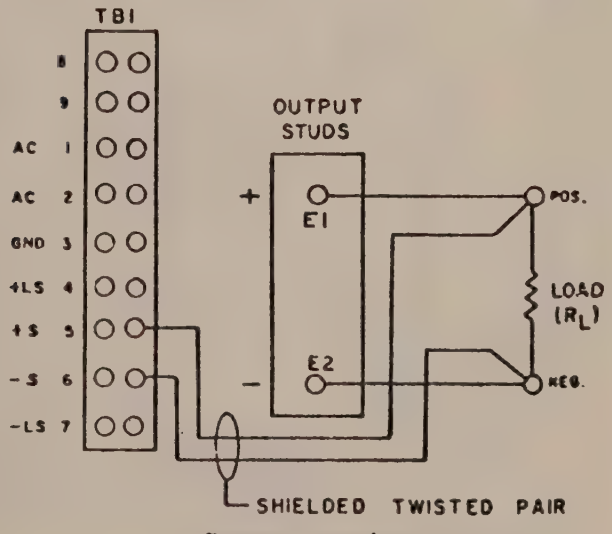
Cable Drop, Millivolts/Ampere, as a Function of Cable Length.

FIGURE 1.



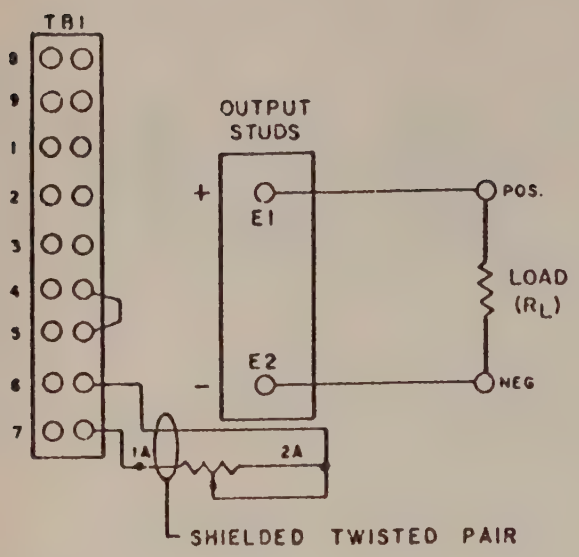
Local Sensing.

FIGURE 2.



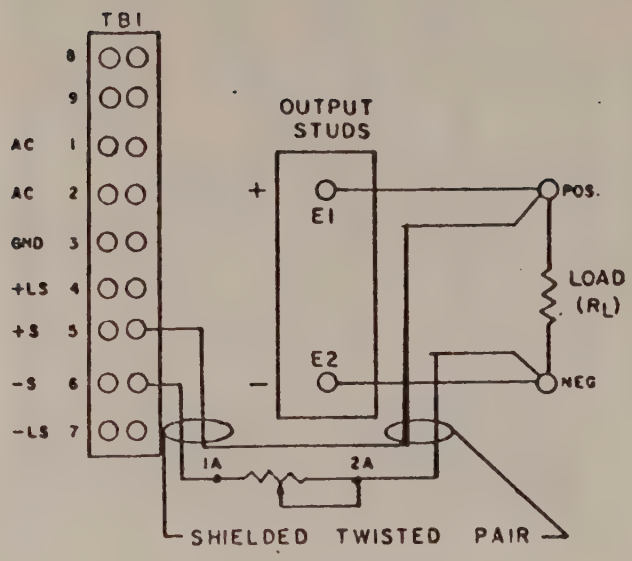
Remote Sensing.

FIGURE 3.



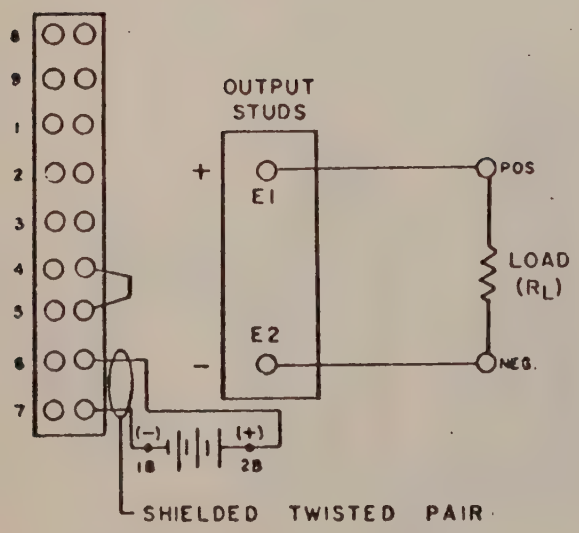
Remote Resistance Programming
with Local Sensing.

FIGURE 4.



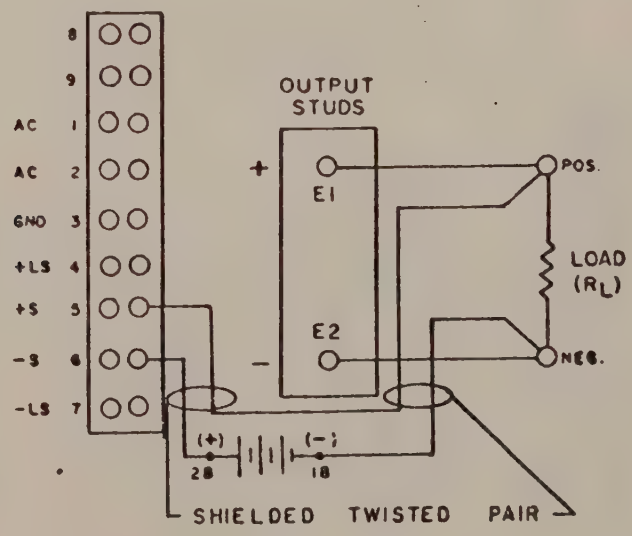
Remote Resistance Programming
with Remote Sensing.

FIGURE 5.



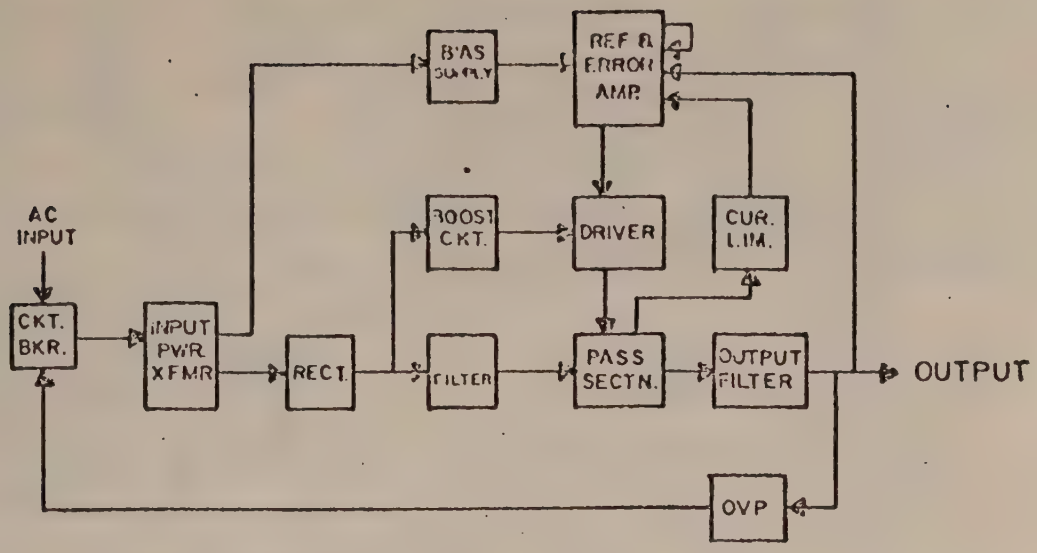
Remote Voltage Programming
with Local Sensing.

FIGURE 6.



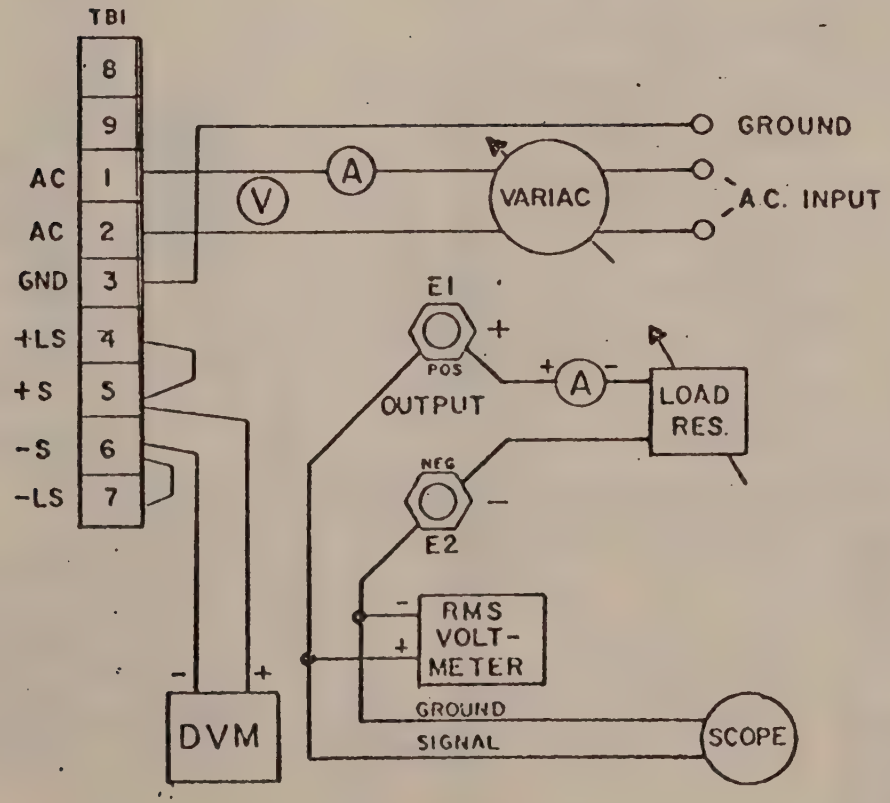
Remote Voltage Programming
with Remote Sensing.

FIGURE 7.



General Circuit Block Diagram.

FIGURE 8.



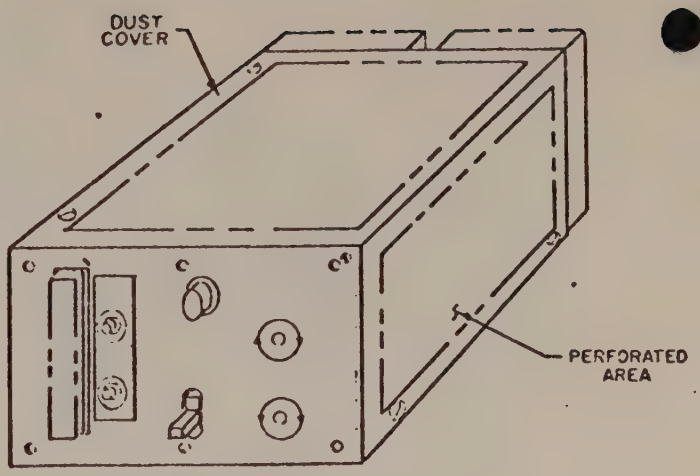
Test Conections for Performance Verification.

FIGURE 9.

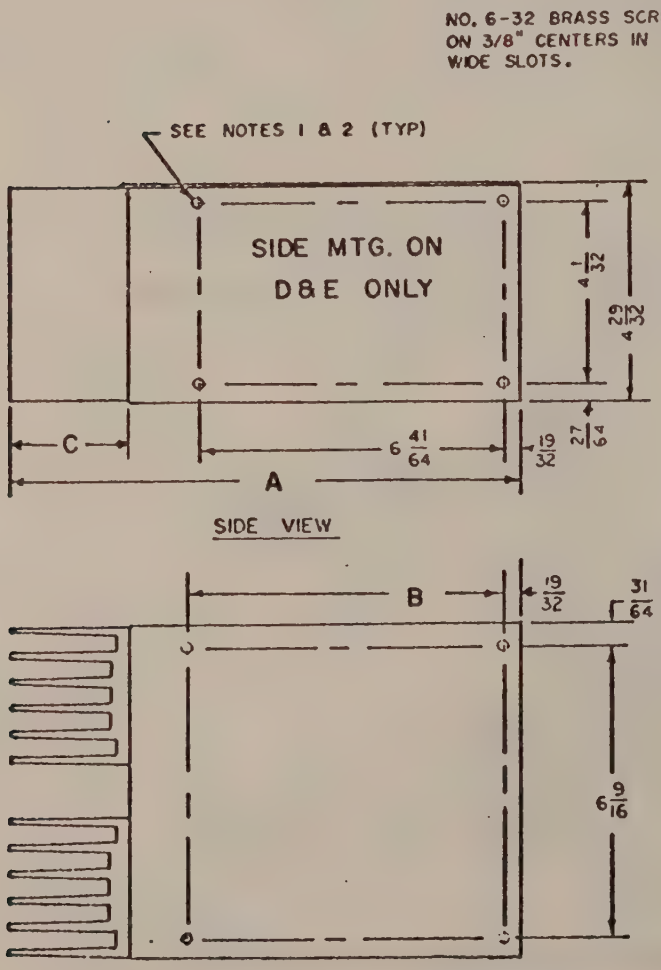
TBI TERMINAL BOARD LEGEND			
TERM NO.	FUNCTION	RECOM'D WIRE SIZE	REMARKS
1	AC		AC
2	AC		AC RETURN
3	G		GROUND
5	+S		JUMPED TO POS OUT
4	+LS		NORMALLY JUMPED TO POS OUT
7	−LS		NORMALLY JUMPED TO NEG OUT
6	−S		JUMPED TO NEG OUT
8			SPARE
9			SPARE
E1	POS OUT		POSITIVE OUTPUT
E2	NEG OUT		NEGATIVE OUTPUT

NOTES

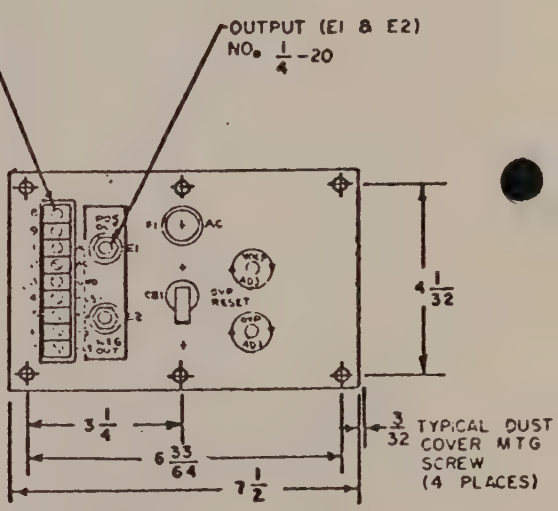
1) NO. 8-32 THREADED MOUNTING HOLES. (TYP 14 PLACES)
2) RECOMMENDED SCREW LENGTH IS 3/8" LONG PLUS THICKNESS OF MOUNTING SURFACE.
3) ALL DIMENSIONS ARE ± 1/64".



TERMINAL BOARD END



SIDE VIEW



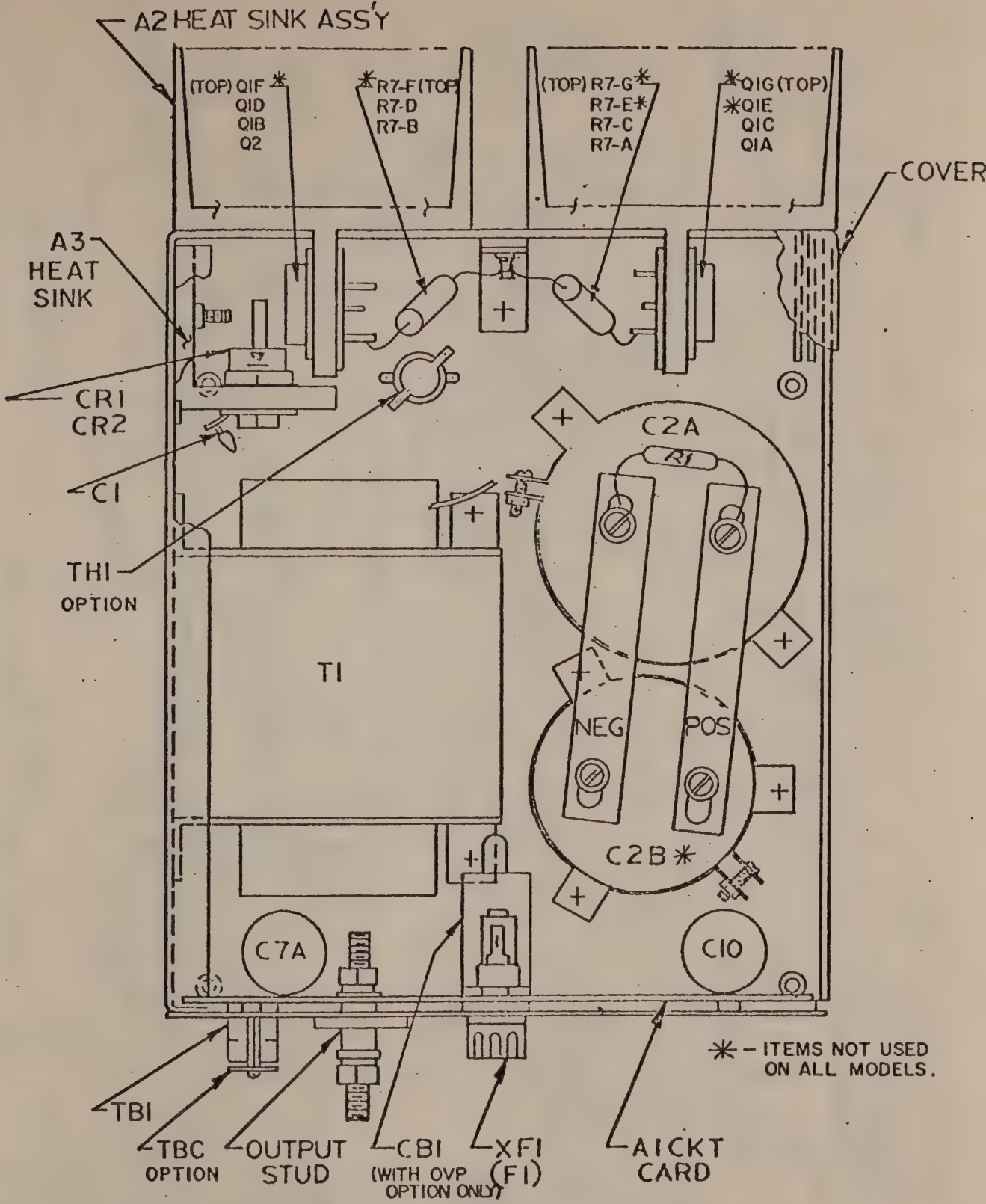
FRONT END VIEW

BOTTOM VIEW

CASE SIZE	DIMENSIONS		
	A	B	C
D	9 51/64	6 57/64	51/64
E	11 3/4	6 57/64	2 3/4
EE	16 1/2	12 3/8	2 3/4

RJ, RS2, RX2
CASE D, E & EE
OUTLINE AND INTERFACE DRAWING
FIGURE 10.

d



RJ, RS2, RX2

CASE D, E, & EE

PARTS PLACEMENT DIAGRAM

FIGURE 11.

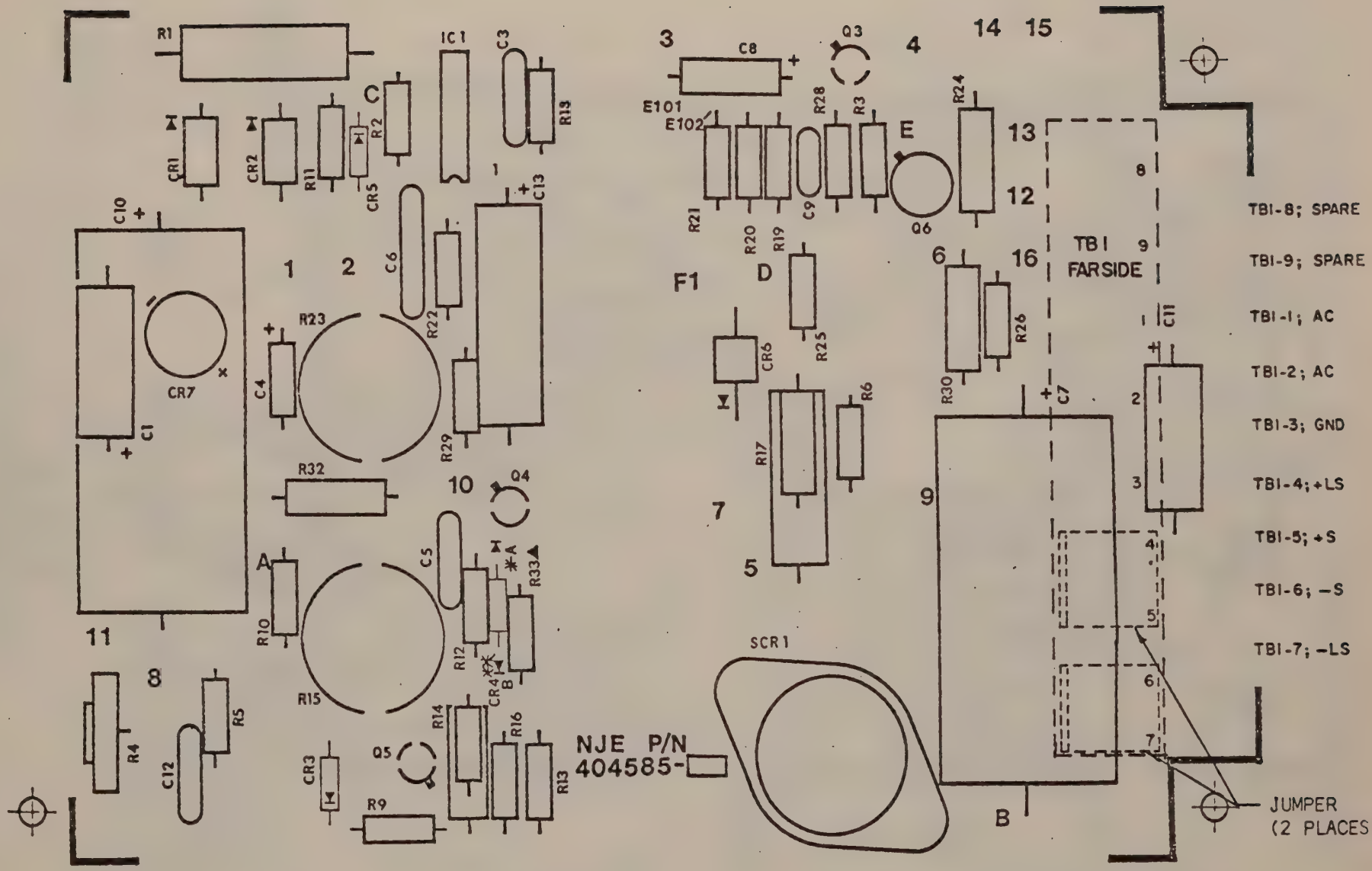


FIGURE 12

PARTS PLACEMENT — AI CIRCUIT CARD

RJ/RS2/RX2- D, E, EE SERIES

NOTES:

"▲" — R33 NOT USED ON ALL MODELS.

"*" — CR4A, USED ON 2V & 5V UNITS ONLY.

"**" — CR4B, USED ON ALL OTHER UNITS.

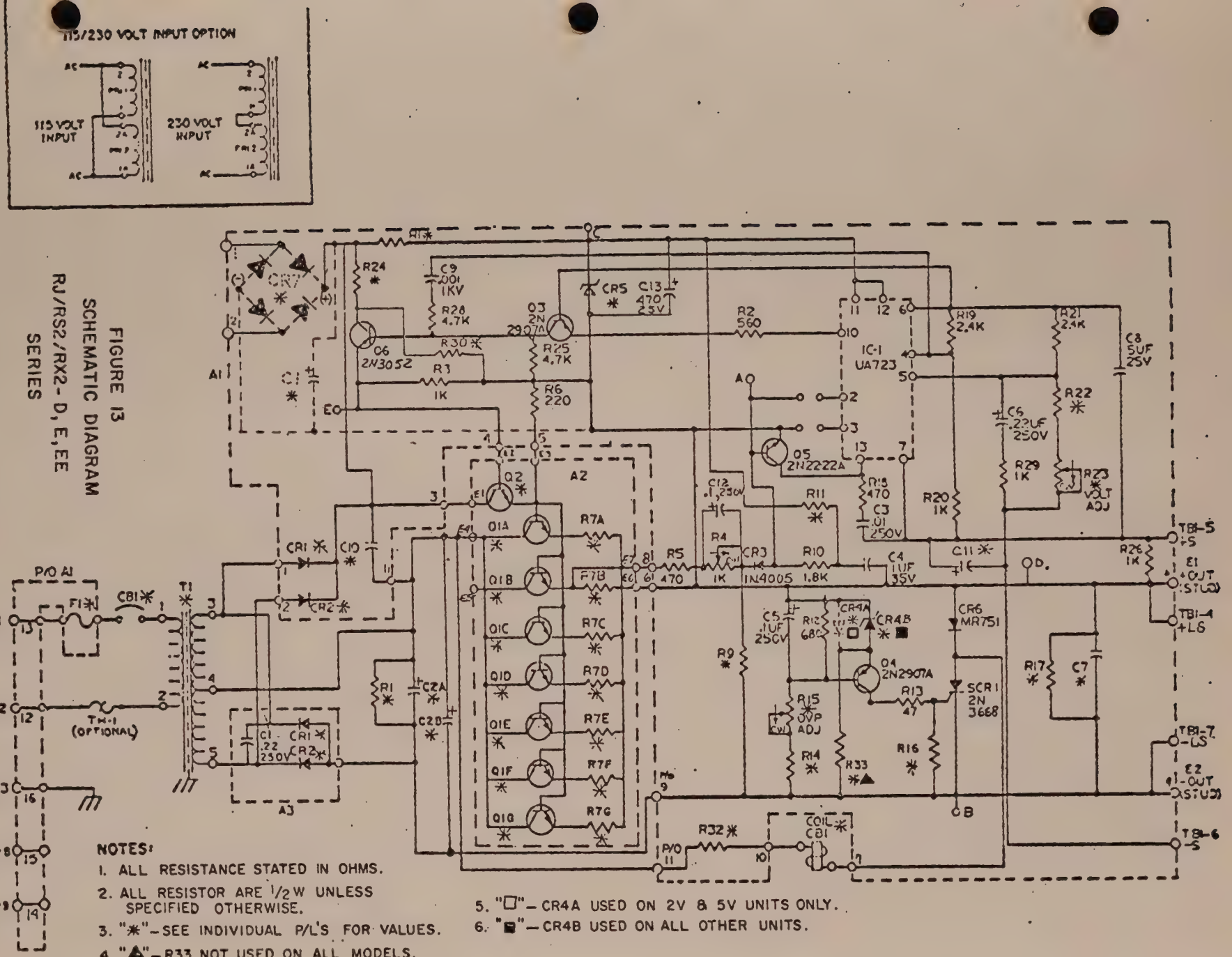


FIGURE 13
SCHEMATIC DIAGRAM
RJ/RS2/RX2-D, E, EE SERIES

NOTES:

1. ALL RESISTANCE STATED IN OHMS.
2. ALL RESISTOR ARE 1/2 W UNLESS SPECIFIED OTHERWISE.
3. "*"– SEE INDIVIDUAL P/L'S FOR VALUES.
4. "▲"– R33 NOT USED ON ALL MODELS.
5. "□"– CR4A USED ON 2V & 5V UNITS ONLY.
6. "■"– CR4B USED ON ALL OTHER UNITS.

POWER SUPPLY
INSTRUCTION MANUAL

MODEL RS2EE48-5S

NJE
POWER SUPPLIES

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FAX (201) 329-6185

(201) 329-4611

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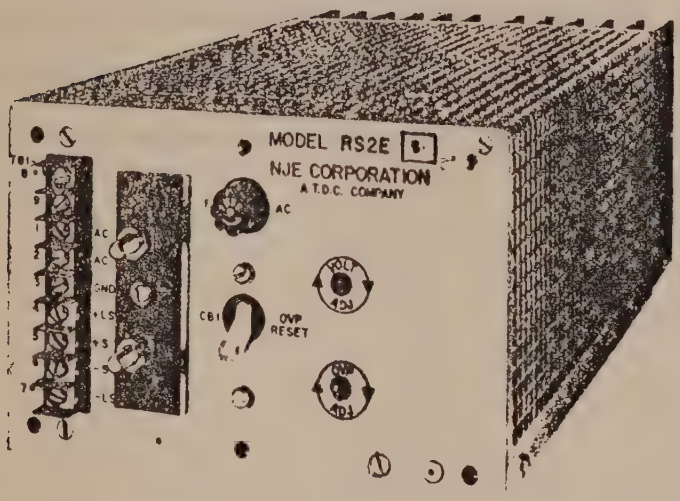
MODELS RJ, RS2, RX2

D, E, EE SERIES

POWER SUPPLIES



instruction manual

NJE POWER SUPPLIES

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(201) 329-4611

POWERellability. Guaranteed.

SERIES START OPTION

GENERAL DESCRIPTION. The Series Start Option consists of a small printed circuit card containing the circuitry which holds off the power supply module's current limiter until the supply is up to rated voltage. Also included is a reverse polarity protection diode which is installed across the module's output terminals. If additional information is required, consult factory.

NJE CORP. DAYTON, N.J.	SIZE	DATE	DWG. NO.	
	A	9/9/87	117831-010	
	SCALE	REV.	SHEET 1	OF 1

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SECTION I

INTRODUCTION

1-1. SCOPE.

This manual is intended for use as a complete guidebook and reference document pertaining to the installation, testing, maintenance, and repair of the NJE D, E, & EE series modular power supply. Complete parts placement drawings, schematic diagram, test voltage, installation diagrams, and troubleshooting chart are included for the installation and maintenance of the D, E, & EE series power supply.

1-2. FUNCTION.

The RS, RS2, and RX2 series D, E, & EE power supply is a self-contained solid state unit operating from the AC line and supplying well-regulated DC voltage and current to electronic equipment. This power supply series is intended for low to medium current applications.

1-3. PERFORMANCE.

The NJE RJ, RS2, and RX2 line of power supplies are all silicon solid state circuits and include the utilization of integrated circuits. Additionally, all supplies are series regulated and are manufactured with high quality industrial grade components. The quality of the power supply is consistent with that required for the most sophisticated computer grade electronic systems in use today. The circuits used are extremely reliable and feature a high degree of simplification. The circuit simplification results in standardization of material and also gives greater reliability due to the reduction of components used in the basic circuits. The overall design philosophy utilized in this product line is based on standardization, simplicity, reliability, and high quality. For the output current ratings and voltages of standard models available in the D, E, & EE series, refer to Table 1A, 1B, and 1C respectively.

1-4. COMPARATIVE SPECIFICATIONS.

Table 2 lists in chart form the specifications of the RJ, RS2, and RX2 models of the D, E, & EE series power supply.

1-5. FEATURES.

1-5-1. OVER VOLTAGE PROTECTION (OVP) (Optional). SCR crowbar to limit maximum output voltage. Normally factory set at 1.5V or 20% (whichever is greater) above the nominal output voltage. OVP may be readjusted by customer via accessible adjustment. (See Maintenance Instructions)

1-5-2. CURRENT LIMITING. Current limiting may be set to limit maximum current from 75% to 125% of rated current. This current limiting adjustment is located internally and can be readjusted by customer. (See Maintenance Instructions)

TABLE 1A

VOLTAGE AND CURRENT RATINGS, D SERIES POWER SUPPLY

MODEL	VOLTAGE RANGE	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE			
		40°C	50°C	60°C	71°C
RJD 2	2± 0.1V	32.5	28.0	23.0	18.0
RS2D5/OVP	5± 0.5V	27.5	23.0	19.0	15.0
RX2D5/OVP	5± 0.25V	32.5	28.0	23.0	18.0
RJD5/OVP	5± 0.25V	32.5	28.0	23.0	18.0
RS2D 10	10± 1.0V	20.0	17.0	14.0	11.0
RS2D 12	12± 1.0V	18.0	15.3	13.0	9.9
RX2D 12	12± 0.6V	21.0	17.8	14.7	11.5
RJD 12	12± 0.6V	21.0	17.8	14.7	11.5
RS2D 15	15± 1.0V	15.0	13.0	10.5	8.2
RX2D 15	15± 0.75V	18.0	15.3	13.0	9.9
RJD 15	15± 0.75V	18.0	15.3	13.0	9.9
RS2D 18	18± 1.0V	13.0	11.1	9.1	7.2
RS2D 24	24± 1.0V	10.5	9.0	7.3	5.7
RX2D 24	24± 1.0V	12.5	11.0	8.7	6.8
RJD 24	24± 1.0V	12.5	11.0	8.7	6.8
RS2D 28	28± 1.0V	9.5	8.0	6.6	5.2
RX2D 28	28± 1.0V	11.0	9.0	7.7	6.0
RJD 28	28± 1.0V	11.0	9.0	7.7	6.0
RS2D 48	48± 2.0V	5.0	4.3	3.5	2.8
RX2D 48	48± 2.0V	6.5	5.5	4.6	3.6

Notes:
1. Current range must be chosen to suit the appropriate maximum ambient temperature.
2. Current ratings apply for entire voltage range.
3. D.C. output voltage regulated for line and load.

TABLE 1B

VOLTAGE AND CURRENT RATINGS, E SERIES POWER SUPPLY

MODEL	VOLTAGE RANGE	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE			
		40°C	50°C	60°C	71°C
RJE 2	2± 0.1V	41.0	34.0	29.0	22.0
RS2E 5/OVP	5± 0.5V	35.0	30.0	24.0	20.0
RX2E 5/OVP	5± 0.25V	41.5	34.0	29.0	22.0
RJE 5/OVP	5± 0.25V	41.5	34.0	29.0	22.0
RS2E 10	10± 1.0V	24.5	20.8	17.2	13.5
RS2E 12	12± 1.0V	22.5	19.1	15.7	12.3
RX2E 12	12± 0.6V	27.0	23.0	19.0	15.0
RJE 12	12± 0.6V	27.0	23.0	19.0	15.0
RS2E 15	15± 1.0V	19.0	16.0	13.3	10.4
RX2E 15	15± 0.75V	23.0	20.0	16.0	13.0
RJE 15	15± 0.75V	23.0	20.0	16.0	13.0
RS2E 18	18± 1.0V	15.0	12.8	10.5	8.3
RS2E 24	24± 1.0V	13.5	11.5	9.4	7.4
RX2E 24	24± 1.0V	15.5	13.0	11.0	8.5
RJE 24	24± 1.0V	15.5	13.0	11.0	8.5
RS2E 28	28± 1.0V	12.0	10.0	8.4	6.6
RX2E 28	28± 1.0V	14.0	12.0	9.8	7.7
RJE 28	28± 1.0V	14.0	12.0	9.8	7.7

NOTES:
1. Current range must be chosen to suit the appropriate maximum ambient temperature.
2. Current ratings apply for entire voltage range.
3. DC output voltage regulated for line and load.

TABLE 1C

VOLTAGE AND CURRENT RATINGS, EE SERIES POWER SUPPLY

MODEL	VOLTAGE RANGE	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE			
		40°C	50°C	60°C	71°C
RJEE 2	2V± 0.1V	44.5	37.8	31.1	24.4
RS2EE 5/OVP	5V± 0.5V	44.5	37.8	31.1	24.4
RX2EE 5/OVP	5V± 0.25V	52.5	44.6	36.7	28.8
RJEE 5/OVP	5V± 0.25V	60.0	51.0	42.0	33.0
RS2EE 12	12V± 1.0V	29.0	24.6	20.3	15.9
RX2EE 12	12V± 0.6V	34.0	28.9	23.8	18.7
RJEE 12	12V± 0.6V	34.0	28.9	23.8	18.7
RS2EE 15	15V± 1.0V	24.5	20.8	17.1	13.4
RX2EE 15	15V± 0.75V	29.0	24.6	20.3	15.9
RJEE 15	15V± 0.75V	29.0	24.6	20.3	15.9
RS2EE 24	24V± 1.0V	17.0	14.5	11.9	9.3
RX2EE 24	24V± 1.0V	20.0	17.0	14.0	11.0
RJEE 24	24V± 1.0V	20.0	17.0	14.0	11.0
RS2EE 28	28V± 1.0V	15.0	12.7	10.5	8.2
RX2EE 28	28V± 1.0V	18.0	15.3	12.6	9.9
RJEE 28	28V± 1.0V	18.0	15.3	12.6	9.9
RS2EE 36	36V± 1.5V	12.0	10.2	8.4	6.6
RX2EE 36	36V± 1.5V	14.0	11.9	9.8	7.7

NOTES:
1. Current range must be chosen to suit the appropriate maximum ambient temperature.
2. Current ratings apply for entire voltage range.
3. D.C. output voltage regulated for line and load.

1-5-3. REMOTE PROGRAMMING. 1 volt per volt or 500 ohms per volt (output terminal strip). See Section II for detailed connection information to operate supply in remote programming mode.

1-5-4. REMOTE SENSING. Sensing terminals separate from the load terminals provide regulation of the voltage at the load rather than regulation of the voltage at the power supply output terminals. This eliminates loss of load regulation due to the voltage drop in the wires connecting the supply to the load.

1-5-5. FAULT PROTECTION. All power supplies are protected with primary fuses and/or circuit breakers.

1-5-6. MISCELLANEOUS FEATURES. The following features are optionally available on these series power supplies: terminal board cover for input connection protection; line cord (3-wire, U-ground); special RMS input voltages with nominal values of 208, 220, 230, and 240 - range is ±10%.

1-6. ENVIRONMENTAL REQUIREMENTS.

The D, E, & EE series power supply is designed to be operated in a free-air (convection) mode. Special cooling and/or forced air (blower or fan) is not required for normal room temperature installations. Room temperature is considered to be nominal at 25° centigrade. However, should the power supply be operated in an ambient environment greater than 40° centigrade, the current output of the supplies must be derated at the rate of (1.5%/°C) up to a maximum ambient operating temperature of 71° centigrade. These series power supplies are commercial-grade equipments intended for fixed ground installation and should not be subjected to extreme adverse conditions of shock, vibration, or salt spray, etc.

1-7. ITEMS FURNISHED.

The D, E, & EE series power supply is furnished complete and pretested and is ready to install using the 8-32 mounting holes provided. Consult the Preparation for Use and Installation section of this manual for installation instructions.

1-8. ITEMS REQUIRED.

Required to put the D, E, & EE series power supply in operation is a suitable 3-wire, U-ground receptacle supplying 115VAC, 60 hertz nominal (except in the case of supplies operated from 187 to 264 VAC line). Wattage requirements are given in Table 2. A line cord will be necessary between power supply and receptacle, unless the line cord option is equipped. Interconnecting wiring from the power supply and equipment being powered is required as determined by the end usage of the power supply. Stranded wire insulated with PVC or teflon covering is recommended for interconnecting wiring and it is recommended that shielded cable be used for sense leads between supply and load if remote sensing is desired. (See Section II for explanation of remote sensing.) Refer to Figure 1 for determination of proper wire size required for the load connections. Additionally, 8-32 x 3/8 long mounting screws are required to fasten the power supply in place.

TABLE 2

TABLE OF SPECIFICATIONS, D, E, & EE SERIES POWER SUPPLY

SPECIFICATION	RS2	RX2	RJ
INPUT REQUIREMENTS	105-132V RMS @ 47-440 HZ.	*105-125V RMS @ 57-63 HZ.	105-125V RMS @ 47-440 HZ.
REGULATION MIN-MAX LINE NO LOAD TO FULL LOAD	 0.01% + 1 mV 0.01% + 1 mV	 0.1% + 1 mV 0.1% + 1 mV	 0.1% + 1 mV 0.1% + 1 mV
RIPPLE AND NOISE	1.0 mV RMS; 3 mV P-P		
TEMPERATURE RANGE OPERATING STORAGE	 -20°C to +71°C -55°C to +85°C	 0°C to +71°C -55°C to +85°C	 0°C to +71°C -55°C to +85°C
STABILITY (LONG TERM DRIFT)	0.1% (24Hr. PERIOD, AFTER 1/2Hr. WARM-UP)		
TRANSIENT RECOVERY TIME	50 MICROSECONDS TO 0.1%		
OVERSHOOT (OUTPUT)	NONE ON TURN-ON OR TURN-OFF		
OVERCURRENT PROTECTION	CURRENT FOLDBACK ADJUSTABLE 75-125% OF OUTPUT RATING		
REMOTE PROGRAMMING RESISTANCE VOLTAGE	 500 OHMS PER VOLT (OR) 1 VOLT PER VOLT		
REMOTE SENSING	PROVIDED		
INPUT PROTECTION	FUSE IN HOLDER AND CIRCUIT BREAKER ON FRONT PANEL		
CONNECTIONS	CINCH 140 TERMINAL BLOCK ON FRONT FOR ALL CONNECTIONS. 1/4-20 OUTPUT STUDS ON FRONT FOR POWER CONNECTIONS		
CONTROLS VOLTAGE ADJUST OVP ADJUST	 SCREWDRIVER ACCESS HOLE LOCATED ON FRONT PANEL SCREWDRIVER ACCESS HOLE LOCATED ON FRONT PANEL		
FINISH	GOLD IRRIDITE ALUMINUM CHASSIS AND HEAT SINKS		
MOUNTING	8-32 TAPPED MOUNTING HOLES PROVIDED ON THREE SURFACES FOR D & E, TWO SURFACES FOR EE		
COOLING	NORMAL CONVECTION COOLING, NO EXTERNAL HEAT SINKS REQUIRED		
SIZE	D	E	EE
	4-29/32" x 7-1/2" x 9-51/64"	4-29/32" x 7-1/2" x 11-3/4"	4-29/32" x 7-1/2" x 16-1/2"
WEIGHT	21 POUNDS	24 POUNDS	31 POUNDS
INPUT POWER REQUIREMENTS	460 VOLT-AMPS	600 VOLT-AMPS	850 VOLT-AMPS

* Units may be operated at 47-53 HZ. by derating to the next highest temperature range. See Table 1A, 1B, or 1C.

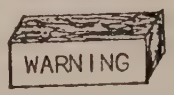
1-9. WARRANTY INFORMATION.

All NJE products listed in this manual are warranted against defects in material and workmanship for FIVE YEARS from date of shipment. This warranty is limited to the cost of parts and labor to restore units to the original factory condition. All shipping costs associated with the units to be repaired and any return shipment damages are the responsibility of the customer. NJE will not be responsible for any failure where the power supply has been used in an application for which it has not been designed or intended. If this power supply is sold to a manufacturer who is using it in a system, as an OEM buyer, which he is reselling, the guarantee above is transferable to the end user.

NOTE: Power supply(s) should not be returned to the factory for inwarranty repair unless the unit remains inoperable after referring to the troubleshooting section of this manual, and carrying out the instructions therein. For repair service or advice concerning an application problem, please contact the factory.

1-10. SAFETY PRECAUTIONS.

HAZARDOUS VOLTAGES. The D, E, & EE series power supplies are powered by 115 volt AC* line voltage which is a hazardous voltage to maintenance personnel. It is recommended the power supply be installed mechanically and the DC output connections be installed prior to plugging in the AC line cords. No hazardous voltages are present to the operator of the equipment during normal usage.



Observe proper safety procedures for 115 volt AC* levels when troubleshooting or servicing these series power supplies.
* (Optional inputs are higher)

Service and troubleshooting should only be performed by a qualified technician.

SECTION II

PREPARATION FOR USE AND INSTALLATION

2-1. PREPARATION FOR USE.

The power supply is shipped in a cardboard carton. Aside from normal precaution against damage to the unit in opening the cartons and removing the unit, no special procedures are required. The carton should be opened immediately upon receipt and the contents inspected for shipping damage. The power supply was checked electrically and mechanically before it left the factory, and is warranged to be in perfect operating condition. This guarantee does not cover possible damage incurred during shipment. Therefore, any evidence of mishandling, such as broken, deformed, or missing parts, should be brought to the attention of the transportation company and a claim should be entered. The literature packed with the supply should be removed and held for reference in operating the equipment. Refer to Figure 10 for an outline drawing of the D, E, & EE series power supply showing assemblies and controls.

2-2. INSTALLATION.

Do not attempt to operate the power supply if obvious mechanical damage has occurred. If the power supply has not sustained any shipping damage it may be installed.

NOTE

Make all connections to the system before applying power.

2-2-1. MECHANICAL INSTALLATION. Mount the power supply mechanically in its cabinet; usually with the equipment to be powered. Standard procedure is to mount the power supply(s) at the bottom of the rack cabinet, but this is not mandatory provided the ventilation requirements of paragraph 1-6 are met. Support the power supply while fastening it in place using four (4) or six (6) screws which must be provided. The power supply mounts by any of 2 or 3 surfaces as shown in Figure 10. Mounting screws should be 8-32 thread, no longer than 3/8" and snugged down tightly (minimum of 10 in-lbs. torque).

2-2-2. DC CONNECTIONS. A pair of 1/4-20 threaded output studs are provided at the front of the D, E, & EE series power supply. Lugs should be attached to the power connection wires prior to fastening to the output studs. Determination of correct wire size for power connections may be made by consulting Figure 1.

NOTE

Do not operate the power supply <u>with</u> the positive and negative sensing leads disconnected either remotely or locally.

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NOTE

Do not operate the power supply <u>with</u> the positive and negative sensing leads disconnected either remotely or locally.

2-2-3. LOCAL SENSING. The power supply is shipped in the local sensing mode. The local sensing mode is illustrated in Figure 2. In this mode, the power supply regulates the voltage at the output terminals and does not account for voltage drop between the output terminals and load. Should optimum regulation at the load be desired, the power supply may be connected in the remote sensing mode.. This and other useful operating modes are described in Section 2-2-4 through 2-2-8.

2-2-4. REMOTE SENSING. In the remote sensing mode, the supply voltage is regulated directly at the load terminals. As a result, regulation is not affected by the voltage drops in the leads connecting the power supply to the load. The remote sensing mode is illustrated in Figure 3. It is recommended that the sensing wires between TB1-5 and 6 to the load be a shielded twisted pair of 20 gauge AWG size.

2-2-5. REMOTE RESISTANCE PROGRAMMING WITH LOCAL SENSING. The remote resistance programming with local sensing mode allows the user to vary the output voltage of the supply without proximity to the power supply. The load regulation is subject to load connection cable voltage drop. The remote resistance programming with local sensing mode is illustrated in Figure 4. It is recommended that the wires between the power supply TB1-6 and 7 to the remote resistance be a 20 gauge AWG shielded twisted pair.

2-2-6. REMOTE RESISTANCE PROGRAMMING WITH REMOTE SENSING. Remote resistance programming with remote sensing allows the user to vary the output voltage of the supply without direct proximity to the supply while maintaining consistent load regulation unaffected by load connection cable voltage drop. This mode of operation is illustrated in Figure 5. It is recommended that the wires from the power supply to the remote resistance and from the remote resistance to the load be a 20 gauge AWG shielded twisted pair.

2-2-7. REMOTE VOLTAGE PROGRAMMING WITH LOCAL SENSING. Remote voltage programming with local sensing allows the user to vary the output voltage of the supply without proximity to the supply. The aforementioned is accomplished by utilizing a programming voltage. The load regulation is subject to load connection cable drops. This mode of operation is illustrated in Figure 6. It is recommended that a 20 gauge AWG shielded twisted pair be used to connect the power supply TB1-6 and 7 to the remote programming voltage.

2-2-8. REMOTE VOLTAGE PROGRAMMING WITH REMOTE SENSING. Remote voltage programming with remote sensing allows the user to vary the output voltage of the supply without proximity to the supply while maintaining consistent load regulation. The output voltage of the power supply if varied utilizing a remote voltage source. The load regulation is not subject to load connection cable voltage drop in this mode of operation, which is illustrated in Figure 7. It is recommended that the wiring from power supply to remote voltage source and from source to load be a 20 gauge AWG shielded twisted pair.

2-2-9. AC CONNECTIONS. Install a line cord with minimum 16 gauge AWG wire with ground to the terminals marked AC, AC, and GND on TB1 at the front of the supply, unless the supply is ordered with the line cord option. Plug this cord into a grounded, 115 VAC, 60 hertz receptacle. Special voltage input power supplies may be provided with a plug and receptacle at the user's discretion, such as a TWIST-LOK plug for 230 VAC. The power supply is now ready to be operated.

SECTION III

THEORY OF OPERATION

3-1. GENERAL THEORY OF OPERATION

The input AC is applied through the fuse and the circuit breaker switch* to the primary of the power transformer. AC from the load power secondary is rectified and capacitive filtered to provide the raw DC voltage for the series pass section. This voltage is also peak rectified and filtered in the boost circuit to provide a higher voltage level for the driver(s) on some units. A separate bias winding on the power transformer provides AC voltage which is rectified and filtered to power the control circuitry.

The control circuitry contains an error amplifier and a reference voltage within a 723 Integrated Circuit Regulator. The output voltage is compared to the reference voltage and the error amplifier corrects for any difference. The correction will always oppose any change in the output voltage caused by either input line or output load variation.

The output current is sensed in the pass section and if a pre-set limit is reached the current limiter stage will inhibit the amplifier output and reduce the load current as the load demand is increased (load resistance decreased). This sensing is of the fold back type which lowers the point of current limit as the output voltage falls.

The over voltage protection circuitry is connected directly across the output terminals and senses the output voltage. If this voltage exceeds a pre-set level, a silicon controlled rectifier (SCR) is triggered on which crowbars the output and opens the primary circuit breaker, protecting the load, the supply, and the power line. (For OVP Option)

3-2. DETAILED CIRCUIT DESCRIPTION.

The following descriptions list the components used in these series power supplies and the function of each component used. Refer to the schematic and parts placement drawing at the rear of this manual for specific component location (Figures 11, 12, and 13).

3-2-1. MAIN ASSEMBLY COMPONENTS.

COMPONENT	FUNCTION
* CB1	Interrupts AC power to the primary winding of T1 when OVP network is activated. (With OVP Option only)
F1	Fuse. Protects supply from excessive current conditions.
T1	Power transformer. Electrostatic shielded, vacuum impregnated with epoxy varnish.
C2A, C2B	Main filter capacitors. Reduces ripple voltage to pass section. (C2B not on all units)

COMPONENT	FUNCTION
R1	Bleeder resistor. Provides discharge current path for main filter capacitors.
TH1	Protects the power supply from failing during an overheated condition by opening the transformer primary circuit (Optional).

3-2-2. A1 CIRCUIT CARD COMPONENTS.

COMPONENT	FUNCTION
R1	Limits the current through CR5.
R2	Current limiting resistor for protection of IC1.
R3	Absorbs Icbo of Q2 to prevent thermal runaway.
R4	Variable portion of current limiting network, consisting of R4 and R5.
R5	Fixed portion of current limit network. Determines the minimum value of load current that the circuit will current limit.
R6	Absorbs Icbo of pass transistors Q1A-Q1D or Q1E or Q1F.
R9	Determines the fold back characteristics.
R10	The resistive portion of the RC network that provides current limit delay at turn-on.
R11	Limits current to the base of Q5.
R12	The fixed portion of the voltage divider in the OVP triggering network. (OVP Option)
R13	Limits gate current to SCR1. (OVP Option)
R14	Determines the minimum triggering voltage of the OVP network. (OVP Option)
R15	Variable portion of voltage divider that determines OVP trip level. (OVP Option)
R16	Prevents false triggering of SCR1. (OVP Option)
R17	Output bleeder resistor. Provides discharge current path for C7.
R18	The resistive portion of the RC network that provides frequency compensation for IC1.

COMPONENT	FUNCTION
R19	Forms a voltage divider with R20 to provide a reference voltage at pin 4 of IC1 with respect to pin 7 of IC1.
R20	See R19.
R21	Provides a constant current (approx. 2mA) for the programming resistors R22 and R23.
R22	The fixed portion of the programming resistors. Determines the minimum output voltage level.
R23	The variable portion of the programming resistor network that determines the output voltage level.
R24	Limits the maximum current and reduces the power dissipation of Q6.
R25	Absorbs Icbo of Q6.
R26	Limits the output voltage variation when the positive sense lead is removed. (Normally by-passed when positive sense lead is connected.)
R28	Provides stabilization in conjunction with C9.
R29	In conjunction with C6, improves transient response and reduces output ripple.
R30	Limits voltage to Q6 and limits power dissipation of Q6. (Not used on all models.)
R32	Current limit resistor. Limits surge through CB1 and SCR1 when power supply goes into OVP mode. (OVP Option)
R33	Provides path for bias current flow of CR4.
C1	Filter capacitor for bias supply. (Not used on all models.)
C3	The capacitive portion of the RC network that provides frequency compensation for IC1.
C4	Provides current limit delay at turn-on.
C5	Delays the response of the OVP circuit to prevent false triggering. (OVP Option)
C6	In conjunction with R29, improves transient response and reduces output ripple.
C7A-C7C	Output capacitors. Reduces output noise and provides closed loop stabilization. (C7B and C7C not used on all models.)
C8	Reduces noise at reference portion of IC1. Prevents voltage overshoot at turn-on.

COMPONENT	FUNCTION
C9	Provides stabilization in conjunction with R28. (Not used on all models.)
C10	Filter capacitor for bias supply. (Not used on all models.)
C11	Provides stability during remote sense operation. (Not used on all models.)
C12	Provides stabilization of the current limit circuit.
C13	Prevents turn-on overshoot.
CR1	Rectifier. Provides DC voltage for bias circuit. (Not used on all models.)
CR2	Rectifier. Same as CR1.
CR3	Provides temperature compensation for the current limit transistor, Q5.
CR4	Zener diode. Provides reference voltage for OVP network. (OVP Option)
CR5	12 volt zener diode. Provides regulated voltage for IC1.
CR6	Isolates unregulated voltage from the output. Conducts current through SCR1 to short circuit the output during OVP operation. (OVP Option)
CR7	Bridge rectifier. Provides DC voltage to bias circuit. (Not used on all models.)
Q3	Provides drive from IC1 to Q6.
Q4	OVP transistor. Provides a gate signal to SCR1 during OVP conditions. (OVP Option)
Q5	Current limit transistor. During current limit Q5 conducts, thus decreasing the available output voltage of IC1.
Q6	Current amplifier. Provides base drive to Q2 of A2 Assembly.
SCR1	Silicon Controlled Rectifier. Crowbars circuits output during OVP mode. (OVP Option)
IC1	723 voltage regulator integrated circuit. Provides reference and control circuitry for regulator loop.

3-2-3. A2 HEAT SINK ASSEMBLY.

COMPONENT	FUNCTION
R7A-R7G	Emitter resistors. Provides current sharing of Q1A-Q1G. Also used for current limit sense resistors. (E, F, & G some models only)

COMPONENT	FUNCTION
Q1A-Q1G	Pass transistors. Connected in parallel for current sharing. (E, F, & G some models only)
Q2	Driver transistor. Provides current amplification for pass stage.

3-2-4. A3 HEAT SINK ASSEMBLY.

COMPONENT	FUNCTION
CR1-CR2	Power rectifiers. Provides full wave rectified DC voltage to pass section.
C1	Suppresses commutation spikes.

3-2-5. uA 723 IC PIN DESIGNATION.

PIN NUMBER	FUNCTION
1.	No connection.
2.	Internal current limit - not used.
3.	Internal current limit - not used.
4.	Inverting input.
5.	Non-inverting input.
6.	Reference voltage - nominal 7.1 VDC.
7.	Common.
8.	No connection.
9.	Not used.
10.	Output.
11.	Input voltage to output stage of IC.
12.	Input voltage to low level stages of IC.
13.	Frequency compensation and external current limit control of IC.
14.	No connection.

SECTION IV

OPERATING INSTRUCTIONS

4-1. GENERAL OPERATING INSTRUCTIONS.

The RJ, RS2, and RX2 D, E, & EE series power supply has a minimum of controls and is not difficult to operate. All controls used in normal operation are placed on the front panel and input/output connections are also at the front. The supply may be turned on and off with the circuit breaker on the front panel. All control adjustment procedures are detailed in Section V, Maintenance Instructions.

4-2. CONTROL FUNCTIONS.

The front panel of the D, E, & EE series power supply contains an input terminal board, output terminals, a circuit breaker switch (with OVP only), fuse holder, and voltage adjust control. Also on units equipped with OVP there is an OVP set point adjust control. The function of each of these components follows:

1. CIRCUIT BREAKER. Interrupts AC power to the primary winding of the transformer when OVP network is activiated. Also used as an on/off switch for the power supply. Protects the power supply (and gives visual indication) during over voltage protection.

2. FUSE HOLDER. Contains primary circuit fuse which protects power transformer (and supply) from catastrophic failure.

3. OVP ADJUST POT. Screwdriver adjustment provided on units with OVP option to set over voltage protection set point.

4. VOLTAGE ADJUST POT. Screwdriver adjustment provided to set output voltage within its normal range. See Table 1 for voltage adjust ranges available on standard units.

4-3. NORMAL OPERATION.

Consult Section II for preparation for use and installation instructions. After the power supply is installed, place the circuit breaker in the * upward or "on" position to operate the unit. No initial adjustments are required. (* OVP Option units only)

4-4. OVER VOLTAGE PROTECTION. (OPTIONAL)

If a voltmeter across the supply output registers between 1.0 and 1.5 volts DC, the supply may be in the OVP mode. The output protection crowbar circuit has tripped due to an over voltage condition at the output terminals caused either internally or externally to the power supply. The power supply may be reset to normal operation by turning the circuit breaker to the off position and turning back on (up position) after one or two seconds. Failure of the supply to attain rated output voltage after trying this procedure is a fault condition and the operator should refer to paragraph 5-2, Trouble-shooting Instructions.

4-5. SHUTDOWN.

No special procedure is required for power supply shutdown. Flipping the circuit breaker down to the "OFF" position turns off the supply. For units without a circuit breaker (no OVP Option) removing power to the AC input on TB1-1 and 2 turns off the power supply.

SECTION V

MAINTENANCE INSTRUCTIONS

5-1. ROUTINE MAINTENANCE.

The only routine maintenance of the RJ, RS2, and RX2 D, E, & EE series power supply necessary is cleaning. For other than routing maintenance, refer to paragraph 5-2, Troubleshooting Instructions and paragraph 5-7, Disassembly, Repair, Replacement, Reassembly. The D, E, & EE series power supplies are designed for years of trouble-free service. The only physical maintenance required is once or twice per year (depending on how dirty the environment in which they are mounted) the power supply should be cleaned of dust which may accumulate. Since the power supply is convection cooled, a great accumulation of dust on the perforated dust cover and rear heat sink may in time hinder the free flow of cooling air. This dust accumulation may be removed with a brush or vacuum cleaner with a brush attachment.

5-2. TROUBLESHOOTING INSTRUCTIONS.

Table 3 lists possible equipment malfunctions which may occur to the D, E, & EE series power supply during normal operation. The Table gives symptom, possible cause, and remedy to restore equipment to normal operation. When trouble occurs, systematically check all fuses, primary power lines, and external circuit elements and wiring for malfunction before troubleshooting the power supply equipment. Malfunctions can often be traced to simple causes such as improper sensing, connections, or fuse failure due to fatique.

5-3. VOLTAGE ADJUST SETTING PROCEDURE.

The voltage adjust pot is a screwdriver adjust pot located on the front panel. To adjust, turn the pot with a standard flat screwdriver clockwise to increase voltage and counter-clockwise to decrease voltage. Observe output voltage reading on a test voltmeter and set pot to obtain desired output voltage.

5-4. CURRENT LIMIT SETTING ADJUSTMENT.

The correct setting of the current limit adjust pot (see shcematic and parts placement drawings for location of this control) is such that the supply will begin to fold back its output voltage when output current reaches 120% of rated 40°C current. See Table 1 for correct rated current value.

NOTE

Setting the current limit too close to the nominal current will give poor load regulation.

5-4-1. CURRENT LIMIT ADJUSTMENT PROCEDURE.

The adjustment procedure requires that the power supply module is disconnected from associated equipment, is at an ambient temperature of 25-30°C, and has not been operated with load for at least one hour. Whenever rated output of the supply module cannot be attained, adjust the current limit pot as follows: (see page 5-4)

TABLE 3

TROUBLESHOOTING (Sheet 1 of 2)

SYMPTOM	POSSIBLE CAUSE	REMEDY
No output voltage.	No AC input.	Line cord frayed or pinched - replace.
		AC receptacle inoperative - check line fuses or breaker.
	Blown fuse, F1.	Check fuse F1 on front panel.
	Faulty wiring.	Check output connections for tightness on TB1, E1, and E2.
		Check output cables to equipment being powered for shorts or open leads.
	Faulty rectifiers.	Check main rectifiers CR1 and CR2 for presence of voltage. Rectifiers may be shorted if no voltage present. Likewise check for voltage at emitter of pass transistors Q1A-Q1G. Replace open or shorted components.
	Faulty regulator IC1.	Replace regulator EC1 if above steps do not return output voltage to normal.
Output voltage low.	Power supply operating in current foldback mode.	Remove load, check load value and check for shorts and/or improper supply-load connections.
	Power supply in over voltage protection mode. (OVP Option)	Turn AC circuit breaker off, turn on after one or two seconds.
		If output does not come up, check OVP adjust setting. (See paragraph 5-5.)
		If OVP is set at max and output does not come up, check OVP circuit components: A1-CR4, A1-Q4, A1-SCR1, A1-CR6.
	Faulty current limit transistor A1-Q5	Check current limit transistor for short, replace.
	Voltage regulator IC1 loose.	Check IC1 for tightness in socket.

SYMPTOM	POSSIBLE CAUSE	REMEDY
Cannot adjust output voltage.	Damaged voltage adjust control pot R23.	Check voltage adjust pot R23 on front panel for short or open, replace as required.
	Module operating as constant current source at current limit value.	Remove load, check load value and check for shorts and/or improper supply-load connections.
Output voltage too high.	Improper output terminal connections.	Check output sensing connections from TB1.
	Shorted pass transistor(s) Q1A-Q1G.	Check pass transistor(s) Q1A-Q1E for short, replace if necessary.
Poor voltage regulation.	Loose load connections.	Check supply-load connections.
	Improper sensing connections.	Check supply-load voltage sensing connections. See Section 2-2.
	Voltage regulator IC1 loose.	Check that voltage regulator IC1 is tight in socket.
	Faulty voltage regulator IC1.	Replace IC1 if above steps do not help.
	Power supply in current limiting mode.	Check that the load current does not exceed rating per Table 1. Refer to Section 5-4-1 if any adjustment is required.
High ripple on output.	Improper ground connections.	Ground positive or negative output terminal at the module.
	Faulty filter capacitor(s) C2A and/or C2B.	Check rectifier diodes for short if ripple is over 2 volts, replace if shorted.
Power supply overheats.	Output current too high.	Check that output current does not exceed rated value (See Table 1). If over, check load requirement.
	Poor ventilation.	Check power supply dust cover and cooling holes (and fins where applicable) for blockage by dust or improper installation. (See Section 1-6.)

1. Determine current limit pot designation by referring to schematic in Figure 12. Locate this pot on the module A1 circuit.

2. Remove AC power from power supply system and gain access to current limit pot by removing module cover.

3. Connect power supply for constant voltage with local sensing as shown in Figure 9.

4. Turn voltage adjust control on front panel to minimum output voltage.

5. Apply a resistor load to output terminals so that output current is 120% of 40°C rating of unit. Refer to Table 1, Voltage and Current Ratings for correct rated output current.

6. Using an oscilloscope, Taktronix 503 or equivalent, observe output voltage of supply while adjusting current limit pot in a counter-clockwise direction. Adjust until output ripple increases sharply and oscilloscope pattern changes.

7. Recheck setting by increasing load from rated value to 120% of rated value and observing oscilloscope for sharp increase in output ripple at 120% point. Repeat procedure if necessary.

8. Reassemble top cover.

5-5. OVER VOLTAGE PROTECTION ADJUSTMENT.

The correct setting of the over voltage protection pot (located on the front panel of the supply) is 1.5V or 20% (whichever is greater) above nominal reated output voltage of the supply. Refer to Table 1 for correct output voltage of the unit.

5-5-1. OVP ADJUSTMENT PROCEDURE. (ON UNIT WITH OVP OPTION ONLY)

The adjustment procedure requires that the power supply be disconnected from associated equipment.

1. The OVP pot is on the front panel of these series power supplies.

2. Turn the OVP adjust pot fully clockwise. The correct OVP setting is 1.5V or 20% (whichever is greater) above nominal rated output voltage of the module being adjusted. Refer to Table 1.

3. Turn on the power supply and raise the output voltage to this desired over voltage protection point. Monitor output voltage by connecting an external voltmeter to the output of the supply and raise voltage by adjusting front panel volt adjust pot. Some units will require an external voltage source to set the OVP at the desired voltage.

4. Slowly turn the OVP pot counter-clockwise until the voltmeter suddenly drops to between 1 and 1.5 volts and CB1 (OVP reset) trips indicating that the over voltage protection point is reached.

5. The over voltage protection point is now set. Turn down voltage adjust pot before turning on power supply again.

6. Turn on supply and reset output voltage to correct nominal value. Refer to Section 5-3 for specific voltage adjust setting procedures.

5-6. PERFORMANCE VERIFICATION.

It may be necessary to check the performance of these series power supplies periodically. Specific parameters of performance are given for each of the power supply models in these series in Table 2, Table of Specifications. The power supply parameters may be verified with the test set up illustrated in Figure 9. This testing is to be performed by a trained electronic technician utilizing the following equipment (or equivalent).

1. A variable resistor load appropriately rated for the model being tested.

2. A DC ammeter, 0 to 50 amps, ±2% accuracy.

3. An AC ammeter, 0 to 10 amps, ±2% accuracy.

4. An RMS voltmeter, Ballantine model 320 or equivalent.

5. A digital voltmeter (DVM), Data Precision 902 or equivalent.

6. An AC variac, switched, with grounded 3-wire receptacle, capable of supplying 10 amps AC.

7. An AC voltmeter, 0 to 150 VAC, ±5% accuracy.

8. An oscilloscope, Tektronix model 503 or equivalent.

9. A 5-position terminal board to make connections to the power supply under test.

5-6-1. LINE REGULATION.

Turn on power supply and load to full rated current at 40°C, as listed in Table 1. Measure and record the output voltage of the supply using the DVM at 105 volts AC input. Turn up the variac to 132 volts AC input (for RS2D, E, & EE supplies) to the supply; measure and record output voltage. The difference between these output readings should not exceed 0.01% + 1mV of the maximum reading noted, or 0.1% + 1mV of the maximum reading noted for RX2D, E, & EE and RJD, E, & EE supplies, with a line swing from 105-125 VAC.

5-6-2. RIPPLE.

Measure the RMS ripple on the output of the supply using the RMS voltmeter with the supply at full load as determined in paragraph 5-6-1, and at nominal AC input voltage. Ripple on the DC output should not exceed 1.0 millivolts RMS.

5-6-2. NOISE.

Measure noise on the output of the power supply using the oscilloscope with the supply at full load as in paragraph 5-6-2. Noise should not exceed 3.0 millivolts peak-to-peak.

5-6-3. LOAD REGULATION.

With the supply at nominal input AC voltage, load to full rated current as determined by Table 1; measure and record the output voltage on the DVM. Remove the load and measure and record output voltage. The difference between these readings should not exceed 0.01% + 1mV of the maximum reading obtained for RS2D, E, & EE supplies; or 0.1% + 1mV of the maximum reading for RX2D, E, & EE and RJD, E, & EE supplies.

5-6-4. OVER VOLTAGE PROTECTION CHECK.

The over voltage protection circuit may be checked on the supply while in the test set-up of Figure 9. Refer to paragraphs 5-5 and 5-5-1 for OVP check and reset procedure.

5-6-5. CURRENT LIMITER CHECK.

The power supply current limiter circuit may be checked using the test set-up of Figure 9. With supply on and nominal AC input voltage applied, set the output voltage at minimum, load the supply to full load as in paragraph 5-6-1. Increase load current (decrease load resistance) slowly until the output voltage begins to drop. This is the current limit point. The current limit point or point where output voltage begins to drop should be approximately 120% of the rated output current at 40°C.

5-6-6. DEVIATIONS.

Any deviations from standard as noted in paragraphs 5-6-1 through 5-6-5 when performing any or all tests described may constitute a power supply failure. Refer to paragraph 5-2, Troubleshooting Instructions for possible causes and remedy of power supply failure.

5-7. DISASSEMBLY, REPAIR, REPLACEMENT, REASSEMBLY.

NOTE

Repair in excess of those indicated in Table 3, Troubleshooting, may jeopardize the warranty. Therefore, consult the factory with details for any extraordinary repair that may be required.

Repair of the D, E, & EE series power supply will be limited to replacing defective components found in performance of Maintenance and Troubleshooting techniques as described in paragraphs 5-1 and 5-2, respectively. For location of specific parts and assemblies, please refer to the Parts Placement Diagrams, Figures 11 and 12.

5-7-1. DISASSEMBLY. Disassemble parts in a logical fashion and save all hardware including locking washers so that it may be reassembled as it was taken apart. There are four (4) screws holding the power supply cover. There are five (5) screws holding the A1 circuit card in place which are removed from the front of the unit.

5-7-2. REPAIR, REPLACEMENT. Repair of the power supply and its components is limited to replacement of defective components with new ones and testing as described in paragraph 5-6, Performance Verification. When working with the printed circuit board contained within the power supply, the following techniques should be adhered to if it becomes necessary to change components.

1. Always use a heat sink when soldering transistors and diodes.

2. Broken or damaged printed wiring is usually the result of an imperfection, strain or careless soldering. To repair small breaks, tin a short piece of hook-up wire to bridge the break, and holding the wire in place, flow solder along the length of wire so that it becomes part of the circuitry.

3. When unsoldering components from the board never pry or force loose the part; unsolder the component by using the wicking process. Place the wick onto the soldered connection and apply soldering iron onto the wick, freeing the component, simultaneously remove iron and wick.

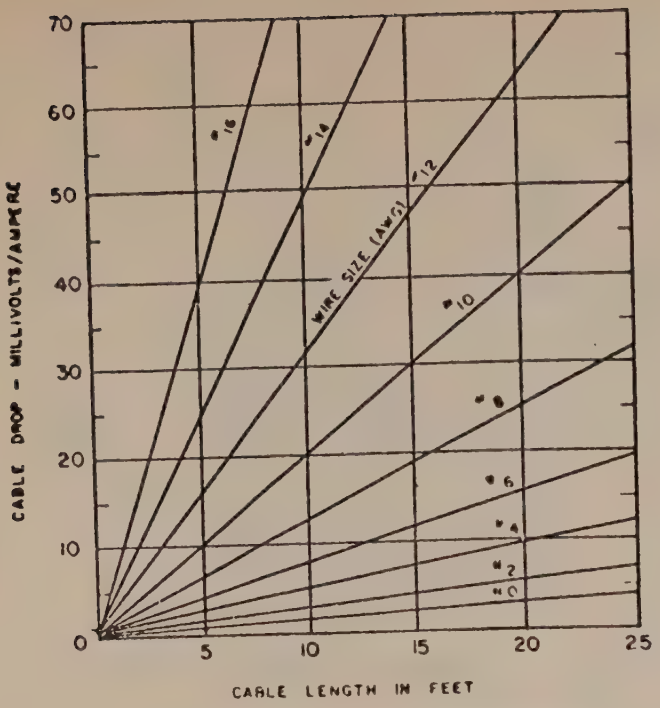
5-7-3. REASSEMBLY. Reassemble the power supply in reverse procedure to that used in disassembly. Be sure to fasten all screws with locking hardware and tighten snugly. Refer to Figures 11 and 12 for complete parts placement diagrams. Upon completion of reassembly refer to paragraph 5-6, Performance Verification, for checking out operation of the power supply.

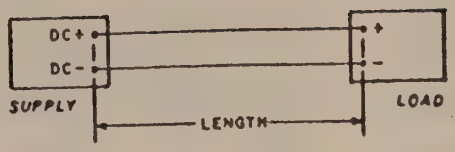
5-8. PACKING FOR RESHIPMENT.

When packaging a power supply for reshipment, roll up the power cord (if equipped) and tie it securely. To prevent scratching and keep out dampness the system may be tied in a plastic bag prior to sealing in a cardboard box. A dessicant may be added to the plastic bag to absorb moisture. The shipping container may be a corrugated, cardboard box tailored to fit the supply snugly or fitted with wadding or extra pieces of cardboard. The power supply should not be loose in its shipping container. Mark container adequately as to contents.

5-9. STORAGE INSTRUCTIONS.

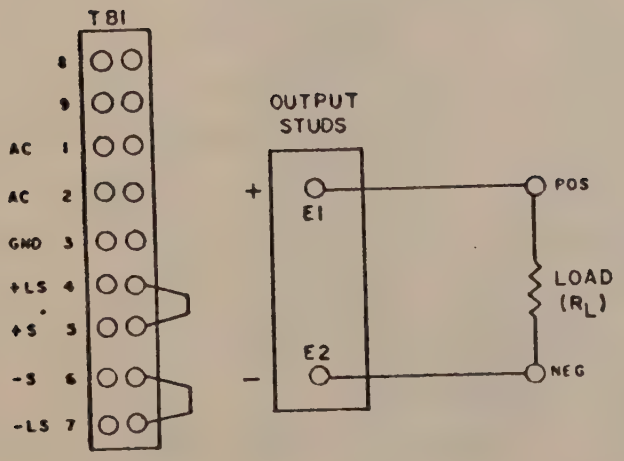
The power supply may be stored open or boxed as in paragraph 5-8. Storage temperature range permissable is -55°C to +85°C. If a power supply is to be stored for a long period of time, a waterproof or overseas shipping container should be used. Avoid storage of electronic equipment in damp areas. When reactivating stored systems after eighteen months or more, it is advisable to check performance as in paragraph 5-6, Performance Verification.





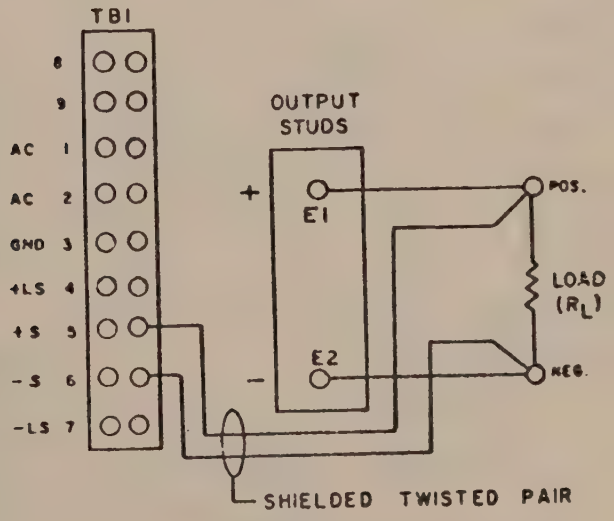
Cable Drop, Millivolts/Ampere, as a Function of Cable Length.

FIGURE 1.



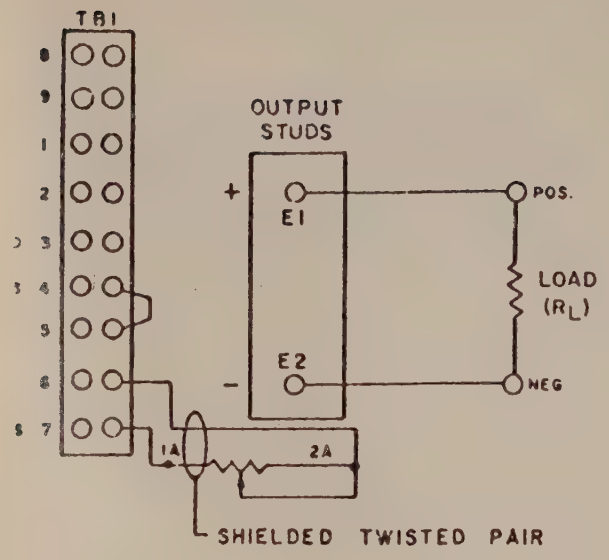
Local Sensing.

FIGURE 2.



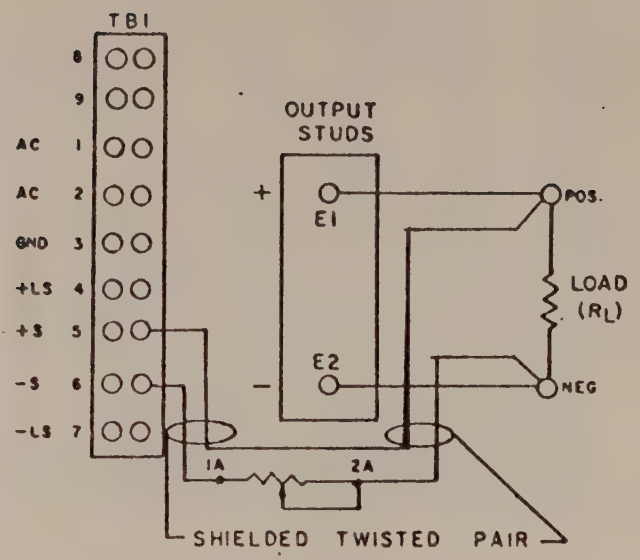
Remote Sensing.

FIGURE 3.



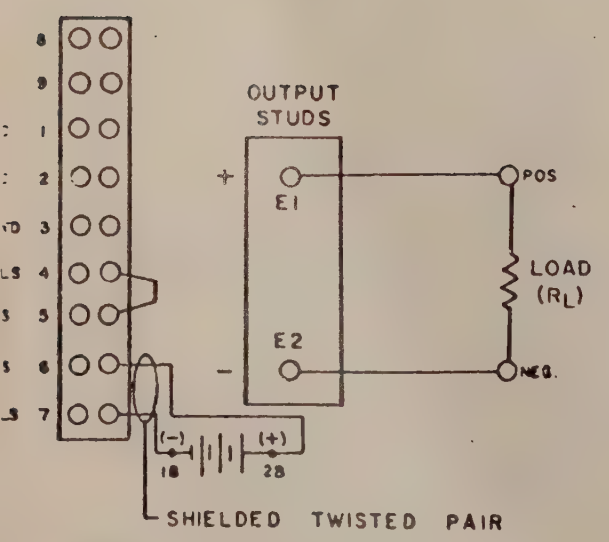
Remote Resistance Programming with Local Sensing.

FIGURE 4.



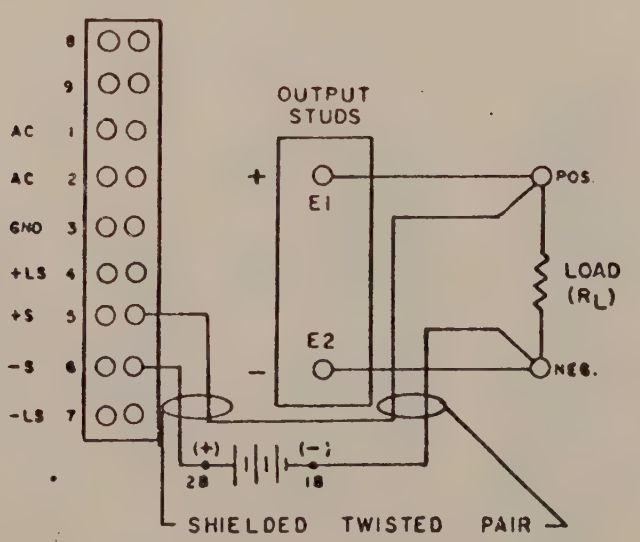
Remote Resistance Programming with Remote Sensing.

FIGURE 5.



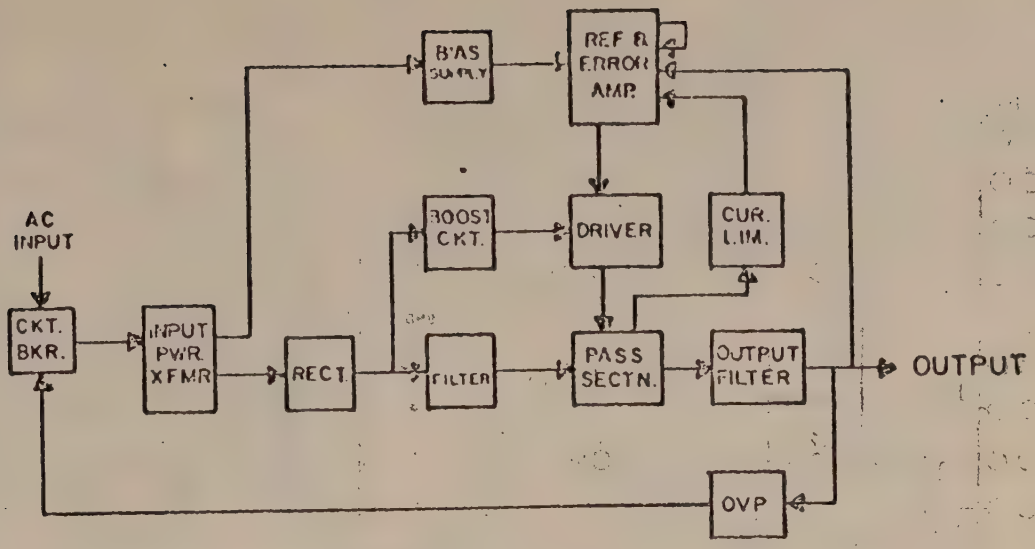
Remote Voltage Programming with Local Sensing.

FIGURE 6.



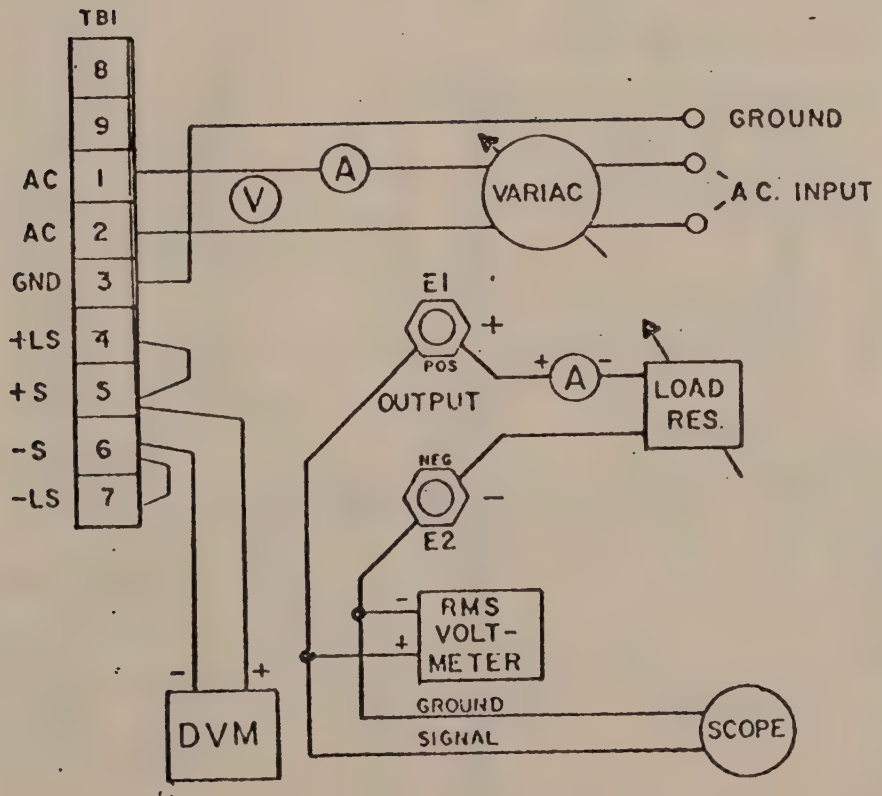
Remote Voltage Programming with Remote Sensing.

FIGURE 7.



General Circuit Block Diagram.

FIGURE 8.



Test Conections for Performance Verification.

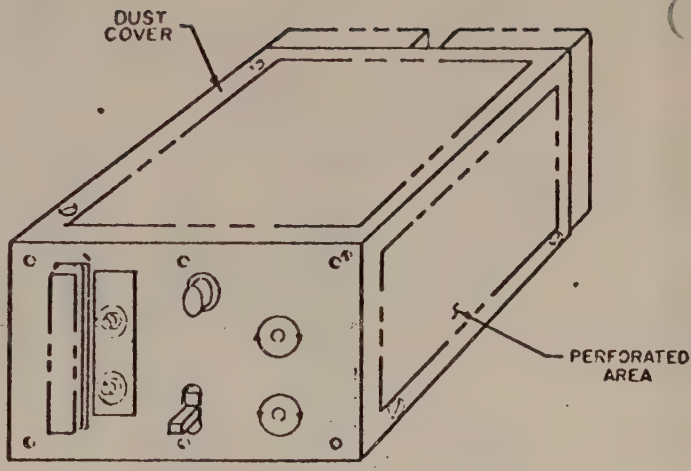
FIGURE 9.

c

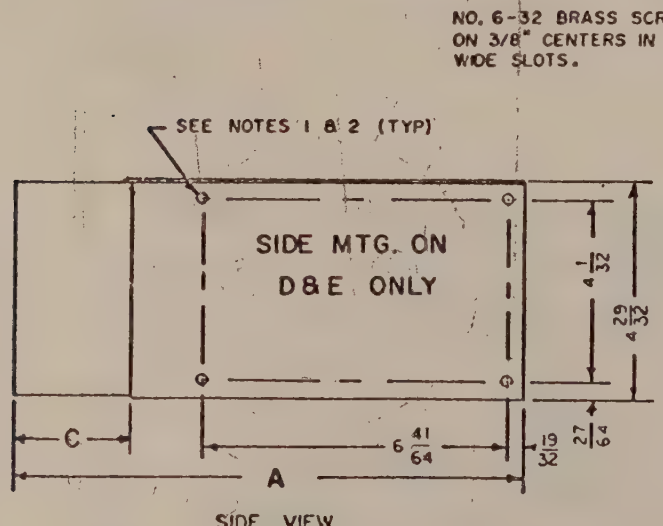
TBI TERMINAL BOARD LEGEND			
TERM NO.	FUNCTION	RECOM'D WIRE SIZE	REMARKS
1	AC		AC
2	AC		AC RETURN
3	G		GROUND
5	+S		JUMPED TO POS OUT
4	+LS		NORMALLY JUMPED TO POS OUT
7	−LS		NORMALLY JUMPED TO NEG OUT
6	−S		JUMPED TO NEG OUT
8			SPARE
9			SPARE
E1	POS OUT		POSITIVE OUTPUT
E2	NEG OUT		NEGATIVE OUTPUT

NOTES

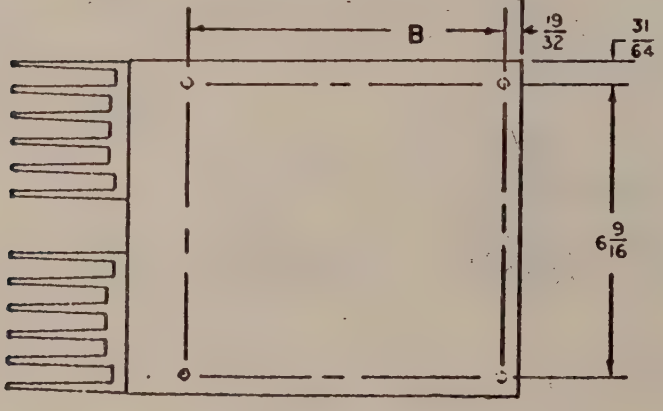
1) NO. 8-32 THREADED MOUNTING HOLES. (TYP 14 PLACES)
2) RECOMMENDED SCREW LENGTH IS 3/8" LONG PLUS THICKNESS OF MOUNTING SURFACE.
3) ALL DIMENSIONS ARE ± 1/64".



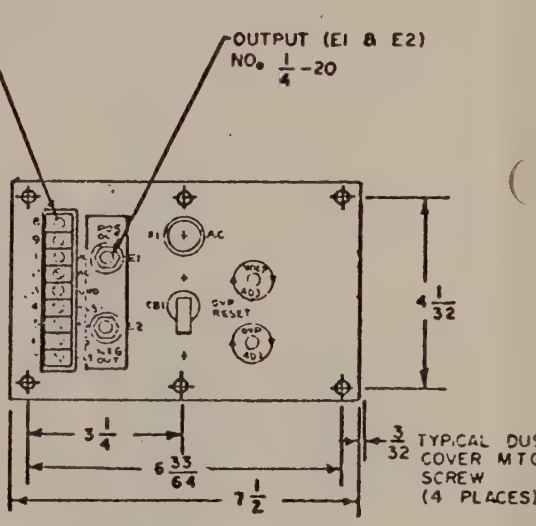
TERMINAL BOARD END



SIDE VIEW



BOTTOM VIEW

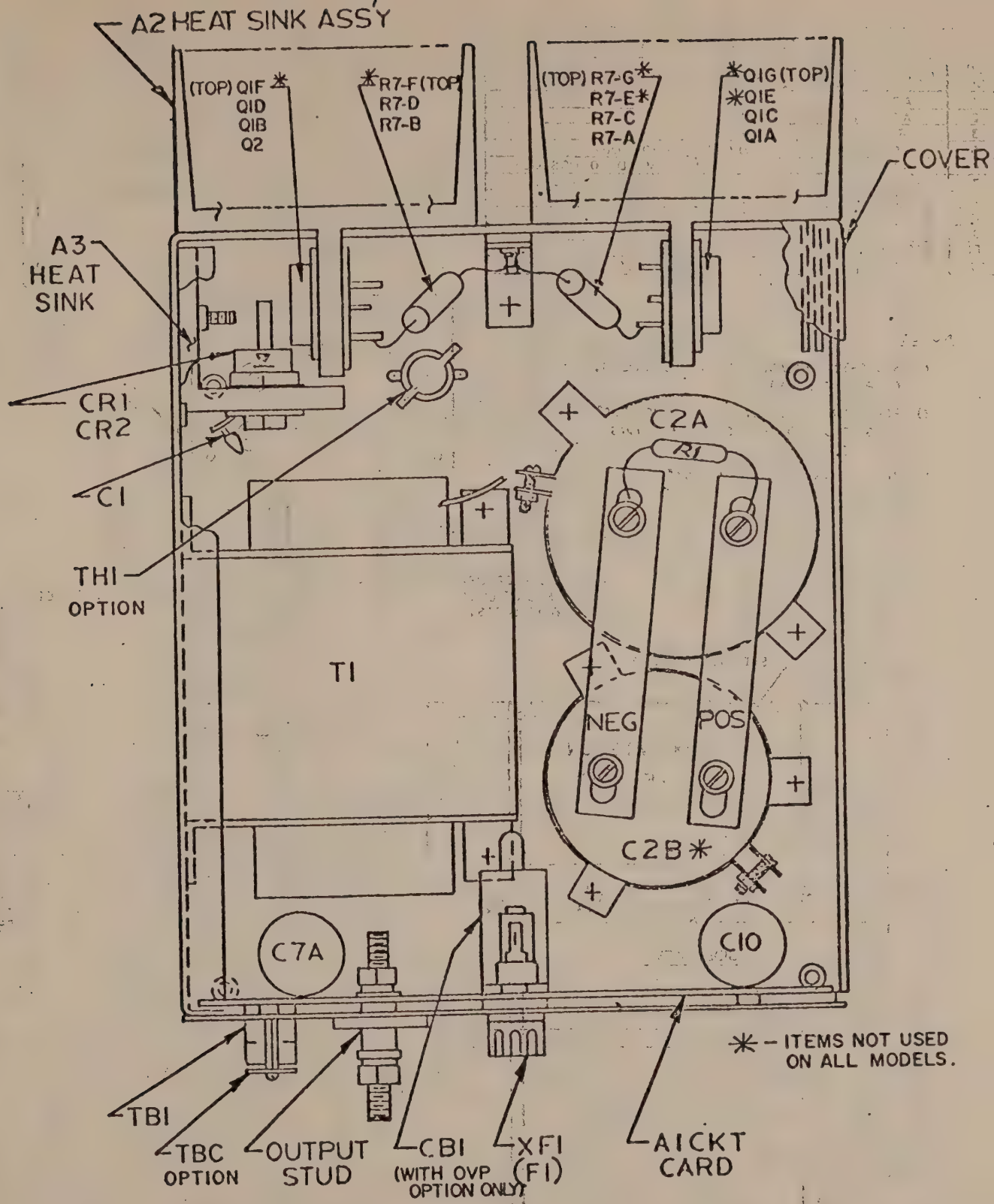


FRONT END VIEW

CASE SIZE	DIMENSIONS		
	A	B	C
D	$9\frac{51}{64}$	$6\frac{57}{64}$	$\frac{51}{64}$
E	$11\frac{3}{4}$	$6\frac{57}{64}$	$2\frac{3}{4}$
EE	$16\frac{1}{2}$	$12\frac{3}{8}$	$2\frac{3}{4}$

RJ, RS2, RX2
CASE D, E & EE
OUTLINE AND INTERFACE DRAWING
FIGURE 10.

d



RJ, RS2, RX2

CASE D, E, & EE

PARTS PLACEMENT DIAGRAM

FIGURE 11.

e

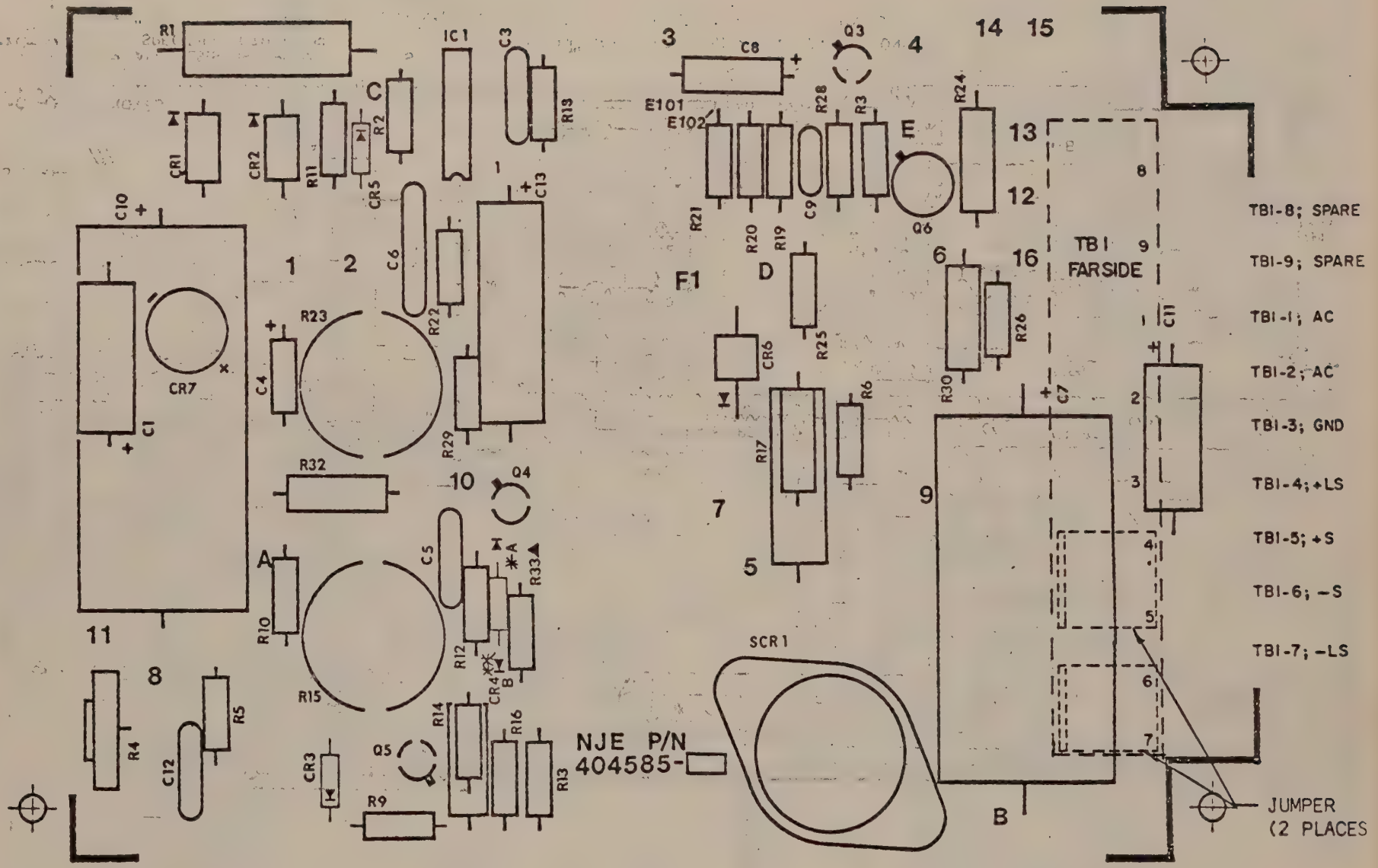


FIGURE 12

PARTS PLACEMENT — AI CIRCUIT CARD

RJ/RS2/RX2- D, E, EE SERIES

NOTES:

"▲" -. R33 NOT USED ON ALL MODELS.

"*" — CR4A, USED ON 2V & 5V UNITS ONLY.

"**" — CR4B, USED ON ALL OTHER UNITS.

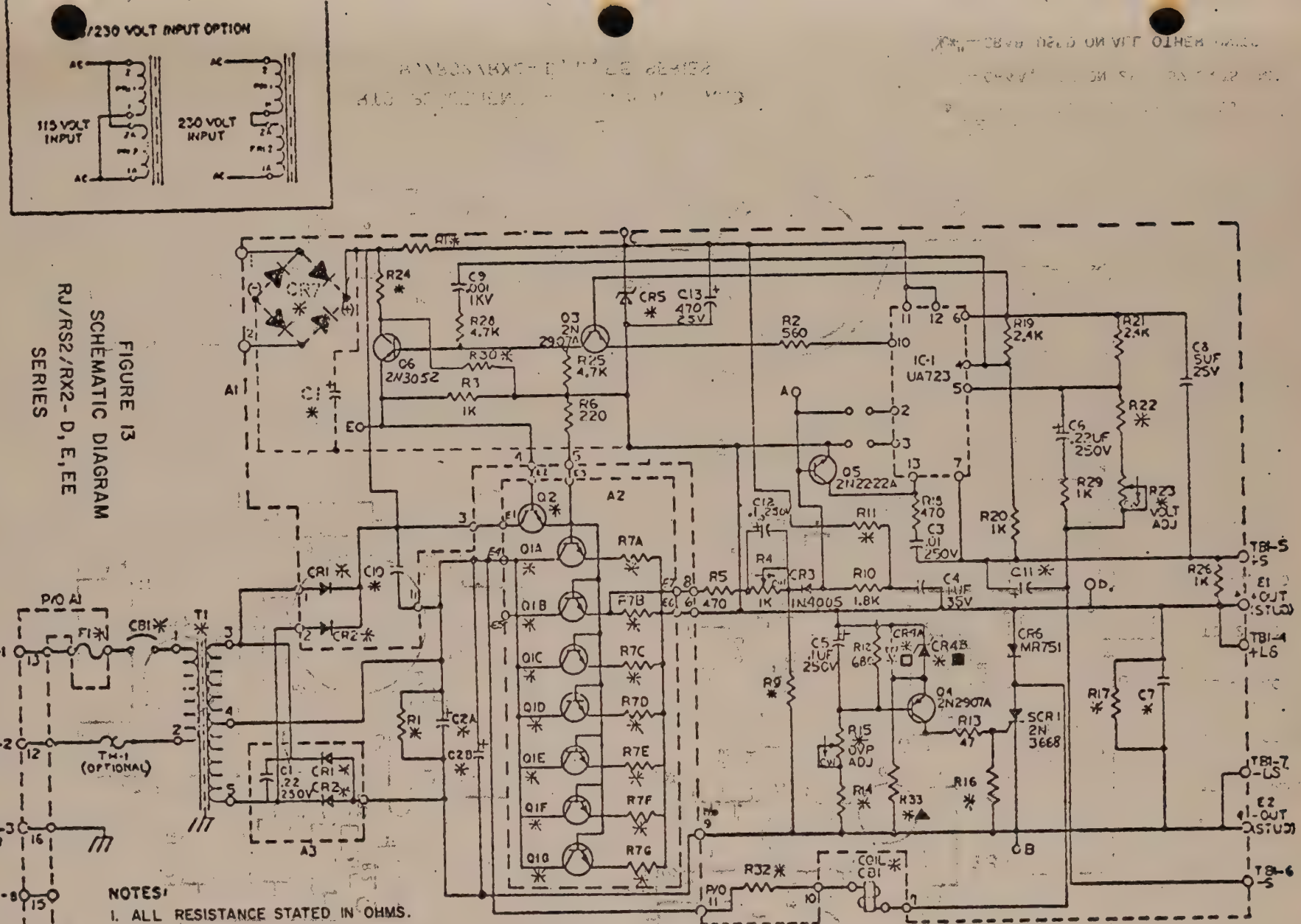


FIGURE 13
SCHEMATIC DIAGRAM
RJ/RS2/RX2- D, E, EE
SERIES

MP MASTER
MA32844